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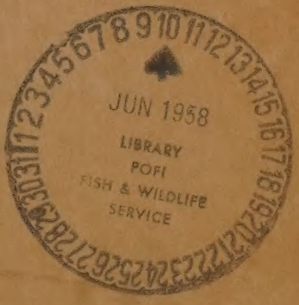

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目　　錄

CONTENTS

1. Liu Fah-hsuen B. Sc. Ph. D: THE LUNAR DIEL PERIODICITY AND THE POPULATION STRUCTURE OF SOME DEMERSAL FISHES 1

2. K. Y. Chu: A LIST OF FISHES FROM PESCADORE ISLANDS 14

3. Liu Fah-hsuen & Shen Shih-chieh: A PRELIMINARY REPORT ON THE ACTIVITY OF WEN-FISHES (HERRING-LIKE FISHES) ALONG THE COAST OF TAIWAN.....24

4. Liu Fah-hsuen & Chen Gin-chen: A THIRD REPORT ON THE STUDY OF THE BLACK CROAKER (ARGYROSOMUS NIBE J. & T.) OF THE NORTHERN TRAWLING GROUND OF TAIWAN.....33

THE LUNAR, DIEL PERIODICITY AND THE POPULATION STRUCTURE OF SOME DEMERSAL FISHES

by

LIU FAH-HSUEN B. SC. PH. D.

Lunar periodicity of animals has been demonstrated by the reproductive behavior of polycheate worms by Scott 1909, Lillie and Just 1913 and Grave 1922 etc. Thompson and Thompson 1919 found also that the grunion, a kind of fish, has the same periodicity as that of the polycheate worms, all these inhabit the littoral region of the sea where the salinity, temperature, food and the rising and falling of the tide are subjected to a large range of variation. It is interesting to know whether fishes inhabiting deeper waters exhibit such lunar periodicity. Moreover, the reproductive activity of the above mentioned animals is always accompanied by their collecting together in swarms. The swarming may be due either to an endogenic factor of reproduction or to an exogenic factor, the light, the tide or others. Anonymous 1943 reported that fish show winter gathering together for warming themselves. Local fishermen of trawl fishery believe that more fish can be caught during periods of neap tide, that is during the quarters of the moon. The latter shows that demersal fishes aggregate more during such tides. (neap tides) or during the quaters of the moon. The writer has seen no scientific report which has proved this to be true. As tide is directly affected by the phases of moon whether it is due to the light of the moon or to the physical forces of tide is a matter importance to know if the fishermen's belief is found to be true and its cause is exogeneous.

The vertical movements of planktons are good examples of the diel periodicity of animals (Clark 1933 and 1934 Juday 1904). The animals activity can be classified generally into several catagories, auroral and diurnal (arrhythmic), vesperal and nocturnal (crepescular). There is no report which deals with fishes in regard to their diel periodicity. Many fishes which are known to be positively phototropic are fished especially at night, yet many are fished during twenty four hours of the day without considering their behavior at different diel periods. The understanding of the diel periodicity of various fishes might be a matter of practical value as well as an offering to science.

The population structure of marine animals is determined by the pattern of its distribution. This distribution is generally classified into three forms, the even distribution, the random distribution and the contagious distribution. The population structure of the distribution of the last kind has given complexities to the study of population density. Cole 1946 has formulated a theory for analyzing contagiously distributed populations. Delury, D. B., 1951, Taylor, C. C. 1953, Rounsefell G. A., 1957 and Hiroshi Mako, 1955 have worked on the population of demersal fish. It seems that the clear understanding of the population structure of the animal is of much importance

before the mathmatical details of analysis reaches to the state of maturity. The writer wishes to express his gratitude to Mr. Chen Gin-chen who has prepared the data and figures of this report.

MATERIAL AND METHOD

The material used is the fishing log of otter trawlers of the China Fishery Corporation. The behavior of the fish is determined by finding the difference of the catch per haul at different occasions. For interpretation of the diel and the lunar periodicity, only the fishing log of seven trawlers whose catching ability is considered to be more identical has been analyzed. As the fishing district number 210 is the main fishing ground of the otter trawlers the analysis is also limited to the fishing log of this district. The black croaker (Argyrosomus nibe), the ribbon fish (Trichiurus lepturus) and the sea eel (Muraenesox cinereus) which are the three abundant species to this district are studied in more detail. The analysis for the study of the population structure has adopted more data than that used above. The logs of all their operating districts have been used.

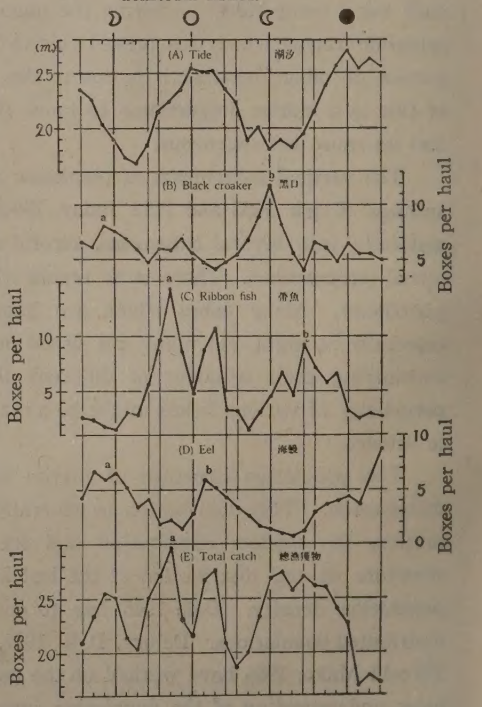
OBSERVATION

a. Lunar periodicity

Figure one shows the lunar periodicity of the black croaker, the ribbon fish, the eel and that of the demersal fishes as a whole together with the rhythm of the tide of a year. The periodicity is interpreted by the average capacity of the catch per unit of effort (boxes per haul). It is clearly indicated that the capacity of catch per haul or the density of fish does vary rhythmically from low to high or vice versa in sequence with the rhythms of the tide or the phases of the moon. However, it is shown differently by different species of fishes.

第一圖 210 區主要底棲魚類及總漁獲物之單位漁獲量與月亮之關係

Fig. 1. Lunar periodicity of important demersal fishes.



The black croaker (fig. 1 B) shows that the capacity of catch per haul increases after full moon and new moon or during the time when the tide changes from spring tide to neap tide. The increase after full moon continues until it reaches the maximum at the highest peak (b) which is just at the third quarter of the moon, but that after the new moon reaches

its maximum at the peak (a) which is one day before the first quarter of the moon. Conversely, it decreases after quarters of the moon or during the time from neap tide to spring tide but this is more clearly shown after the third quarter of the moon than after the first quarter and in both cases there exists irregularity during the process of decreasing.

The ribbon fish (fig. 1 C) behaves quite differently from the black croaker. The capacity of the catch per haul seems to increase after the first and third quarters of the moon that is, when the tide changes from neap tide to spring tide. The increase reaches its maximum two days before the full moon as shown by the peak (a) of the graph and three days after the third quarter of the moon as shown by the peak (b).

The eel (fig. 1 D) behaves almost simillar to that of the ribbon fish but the maximum peaks (a, b, and c) of the graph are very near to the full moon and new moon.

It is clearly seen from the above the tendencg of density variation is the same in the ribbon fish and in the eel but different in the black croaker; actually black croaker and the ribbon fish have greater density during the phases of quarters of the moon (neap tide) while the eel alone has greater density during the phases of full moon and new moon (spring tide) as shown by the peaks of curves in the figure.

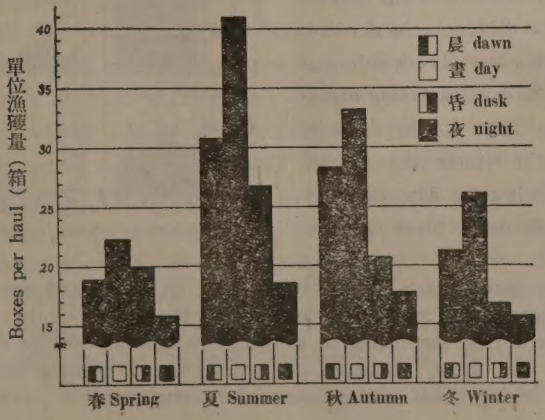
The phenomena of the various kinds of demersal fishes as a whole as seen from the catch per haul of the total catch (fig. 1. E) follow the pattern of the ribbon fish and of the eel in the tendency of density variation, that is the density begins to increase after quarters of the moon, but the density is greater during quarters of the moon than during the full moon and the new moon as the black croaker and the ribbon fish because the large part of the total catch is composed of these two species.

b. The diel periodicity

Figure 2 shows the variation in density of various demersal fishes as a whole being

第二圖 210 區總漁獲物單位漁獲量各季晝夜之變異

Fig. 2. Seasonal variation of catch per haul of various fishes in district 210 during twenty four hours of a day.



determined also by the number of boxes per haul of the total catch. The twenty four hours of a day is divided into four periods, the dawn (5-6AM), the day (9AM-17PM), the dusk (17-21PM) and the night (21PM-5AM). The year is divided into four seasons according to the equinoxes. It may be clearly noted from the figure that the density of the various kinds of demersal fishes varies with the four diel periods. The density is highest during the day and lowest during the night in all the seasons and on the other hand the density during dawn is usually higher than that during dusk in summer, autumn and winter yet in spring the condition is just the reverse.

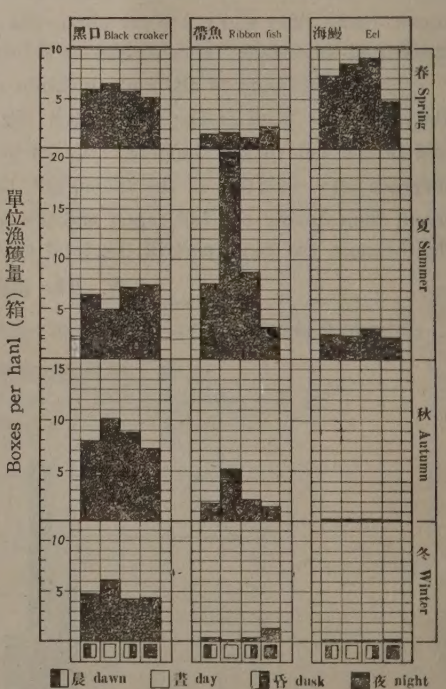
Fig. 3 shows the variation of catch per haul of three independent species, the black croaker, the ribbon fish and the eel. It is found that in general they all agree with the phenomenon shown by various kinds of fishes acting together as mentioned in the preceeding paragraph. However, there exists some minor differences among them.

In spring the density of the black croaker is the highest during the day and lowest during the night while that during dawn is almost the same as that during dusk. The difference of density is as a whole very small during the four diel periods. In summer, the condition is quite different. The density is highest during the night and during the day is found to be the lowest. In autumn, the density of the day is also the highest but that during dusk is higher than that during dawn. In winter, besides the highest density during day, the density during dusk is nearly the same as during night and a little lower than that during dawn.

The action of the ribbon fish is exactly the same as that shown by fishes acting together in summer and in autumn except that in summer the difference in density during day and during night is exceedingly great. In spring, the density during night is the highest and that during dusk is the lowest while in winter the lowest density appears during the day and the highest during night as the black croaker showed in summer.

第三圖　210 區主要底棲魚類單位漁獲量各季晝夜之變異

Fig. 3. Seasonal variation of catch per haul of the main species of fish in district 210 during twenty four hours of a day



The eel is very rare in autumn and in winter. In spring and summer the highest density appears during dusk and the lowest during the night but that during the day is higher than that during dawn and in summer the density during dawn and during the day is almost the same. Because of its scarcity in autumn and in winter any variation existing during those seasons cannot be ascertained.

The population structure

It has been found that the distribution of demersal fishes is contagious i. e. they inhabit in different regions of the sea with different density and the contagiousness seems to vary with different months of a year. (Liu and Cheng 1954 and 1956, Liu and Tung 1956). Figure 4 indicates the distribution of three important species of demersal fishes of the northern trawling ground of Taiwan. The data used for constructing the figure is the fishing log of 1956, which is new, with reference to that used in the previous reports. It shows again that these three important demersal fishes are distributed unevenly in the various fishing districts and the degree of uneveness some times varies from less than one box per haul to more than fifteen boxes.

Figure 4 (A) shows the distribution of black croaker. It is found in January that the district which has the highest density is the district 277 (which averaged more than 15 boxes per haul). District S only yielded 10-14.99 boxes and others like T, 275, 210 and 219 yielded 5–9.99 boxes. The high density is shifted in February from districts 277 to districts T, 388, and 219 and in March it remains only in district 219. In both months the degree of density variation among districts is great, ranging from less than one box to more than 15 boxes. There is no district which yields a density of over 15 boxes per haul in other months of the year. The districts which yield 10–14.99 boxes per haul, the highest density are represented by 219 in April, 200 in June, 200 and 210 in October and 210 in December. The districts 200 and 219 in May, 219 and 210 in July and August and 219 in December yield only 5–9.99 boxes per haul which represents the highest density of the respective months. The highest density drops to 3–4.99 boxes in September as shown in district 210.

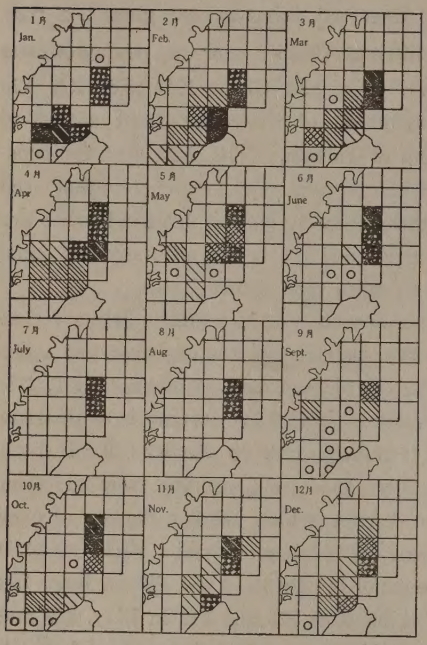
The distribution of ribbon fish (fig. 4B) shows also a certain degree of unevenness. It appears in high density only in a few months of the year and in few fishing districts of the region investigated. The population is not so dense in the months from January to May and from October to December and during these months the degree of variation in density is from less than one box per haul to 1–2.99 boxes per haul which is not as great as the black croaker. Higher density appears in months from May to September. The fish school begins to become dense from May in which month districts 273 and 200 yield 5–9.99 boxes per haul. The highest density (15 and more boxes per haul) is reached in July and appears in district 210, then it decreases gradually and in August and in district 210 the density is only 10–14.99 boxes per haul, in September and in district 210 and 219 the highest density is represented by 5–9.99 boxes per haul. The degree of density variation during the months of high density is usually greater than that during the months of low density.

The distribution of eel (fig. 4C) is very interesting. Like the ribbon fish its great density is only limited to a few months of the year but during the months of low density the distribution is almost even in all the districts. The months in which the population has higher density are from February to June. Highest density appears in April and in district 210 and is more than 15 boxes per haul. In February, May and

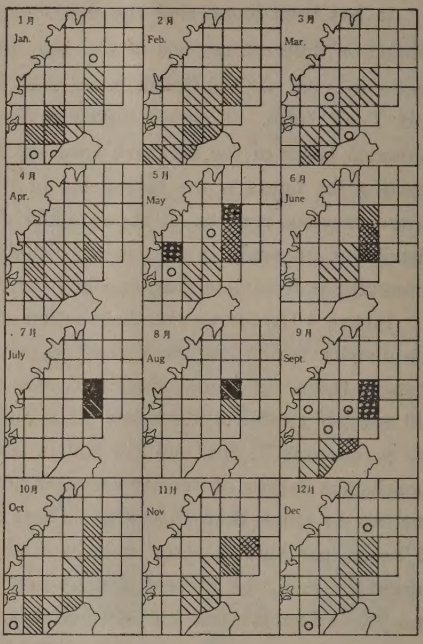
第四圖　幾種底棲魚類之分佈

Fig. 4. Distirbution of some demeresal fishes.

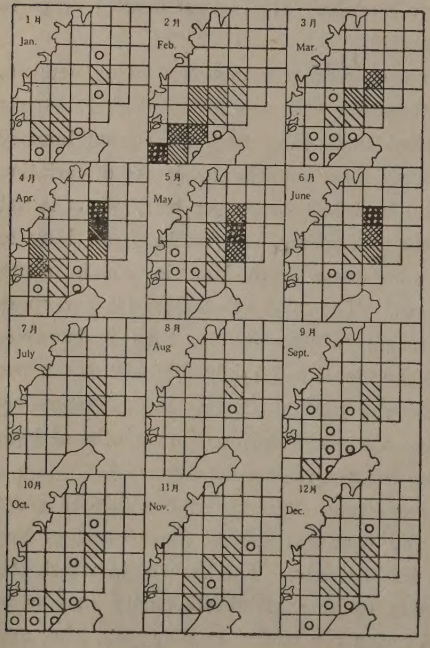
A. 黑口 Black croaker



B. 帶魚 Ribbon fish



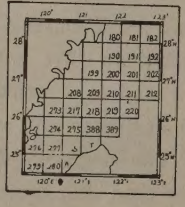
C. 海鰻 Eel



說　明

Explanation

漁區號碼
Fishing districts



記　號
Symbol

- 15箱以上 15 boxes and more
- 10—14.99箱 (boxes)
- 5—9.99箱 (boxes)
- 3—4.99箱 (boxes)
- 1—2.99箱 (boxes)
- 1 箱以下 1 box and less
- 曳網無魚 haul without catch

June the highest density is 5–9.99 boxes per haul appearing in districts 279, 210 and 200 respectively. The highest density is only 3–4.99 boxes in March and appears only in district 210. The degree of density variation is very great in the months with higher density where it is found to vary from less than one box per haul in some districts to more than 15 boxes per haul in others. The months that yield low density are from July to January. The density in these months and almost in all districts is generally below one box per haul. Moreover, these fish are found only in a few districts of the area of present investigation.

It is interesting that difference has been found between the present observation and the observations in the previous reports. (Liu and Cheng 1954, 1956 and Liu and Tung 1956). Besides the minor differences the following has been noticed. The highest density of black croaker which was found in previous years in district 210, is found in districts 277, T, 388 and 219 in the present investigation. April is the month yielding the lowest density in comparison with other months in previous years but in the present investigation the lowest density is found to be in September. The high density of ribbon fish appearing in May and in district 273 was not found in previous investigation although the general distribution of this fish follows generally almost the same pattern in the present and in the previous investigations. The distribution of the eel is also almost the same in both investigations but it seems that the increase in density begins a month earlier this year than last year and the density in districts 210 and 219 which used to be the lowest in April is now found to be the highest. This shows that the density within a district is also subjected to annual variation.

It is found from the present investigation that the distribution of these demersal fishes is not only contagious, or unevenly distributed in form of clusters, the contagiousness is heterogeneous in respect. Heterogeneous means here that the contagious condition is unstable and subject to change due to variation of environmental conditions or to other means i. e. even within a district or a quadrate the density is variable. The heterogeneity is very complicated. Take black croaker as an example, the fishing district 210 has been found to yield the highest density for several years but is lower in density than in the district 219 during 1956 and observations from all data of five years show that the density within the former district varies with months of a year and intermingles with lunar and diel periodicity as present investigation informs.

DISCUSSION

The cause of the lunar periodicity of marine animals often leads to confusion because the variation of the tide are due to the different phases of the moon and they seem to be unseparable. When one considers the moon, the light factor is usually emphasized and by such a concept the density change of the observed fishes is found to be affected by the physical force of tide instead of the light of the moon because same effect is found usually to be produced by both the full moon and the new moon. However, it might be wiser to use the phases of moon than to use the sequences of

tide as indicators for fishing as the observed three species of fishes do not all have the highest density at neap tide e. g. the eel has the highest density during spring tide.

Confusion also exists when effect of change of animal life is produced by an external factor such as the physical force of the tide and at the same time an internal factor such as the state of physiological change. This is characterized by the lunar periodicity of polycheate worms and of the grunion, their swaming may be due to the light of moon or to the sequence of tide and or to the internal physiological change which usually happens in animals during periods of breeding. This confusion does not exist in the life of the observed fishes, the periodicity of which seems to be due simply to the external physical force of the tide since they are so affected during the whole year (in all seasons) although the influence of food elements by tidal cycle remains to be investigated.

If the density change of these fishes could be expressed by the difference in activity of the fishes, the individuals of the school with high density might be less active than that with low density. The observed fishes are generally nocturnal in character because their lowest density appears entirely during the night. There appear seasonal variations by fishes of different species. The black croaker in summer and the ribbon fish in spring and winter are diurnal instead of nocturnal as in other seasons. Summer is found to be the spawning season of the black croaker while the reproductive condition of ribbon fish at the investigated region has not been studied. If the change from nocturnal to diurnal of the black croaker in summer could be due to spawning, the effect of endogenic factor (physiological change due to spawning) seems able to overshadow that of the exogenic factor. This needs to be further verified.

In the present investigation it seems too early to make attempts to find the population density or to estimate the abundance of the population of these demersal fishes because their population structure is very complicated and there still remain some unknown factors. It seems that more observations should be made in order to identify whether the present observed phenomena could be so concluded. Moreover, knowledge of whether the schools of these fishes of the investigated area are independent and whether the investigated area is the whole habitat range of these fishes are important matters to be studied.

The source of material is the fishing log of the commercial trawlers and the complexities existing within it are unavoidable. This is why instead of utilizing special statistical treatments, simple arithmetical method (average per haul) is employed for analysis in the present as well as in previous investigations. However, it seems necessary to notice that the average per haul of equal sized districts (quadrates), each of 90 square miles are used for comparison of the density of different localities and in the study of lunar and diel periodicity, only data of district 210 is used which has been found to be, from records of several years, the district with the highest density of the fishes investigated, provided the fishing effort is considered to be homogeneous. The degree of reliability of the present investigation may still remain for discussion

but the present finding does afford a general picture of the population structure which will help to make more adequate design on census sampling.

"Aacombe (1950) lists seven 2-parameter distributions constructed on models postulating various types of heterogeneous Poisson sampling. Considering only the catch-per-tow* data, there appear to be three of these distributions, in addition to the negative binominal, wich might be applied: the Neyman Type A, the Polya-Aeppli, and the Thomas all three being of the so-called contagious type" said Taylor 1953. The application might be able to be simplified by proper sampling procedure which can be explored through thorough understanding of the fish population structure in nature.

SUMMARY

The demersal fishes of the investigated area change their density in consequence of the rhythm of the tide. Some, as the black croaker, increase their density after full and new moon i. e. during the tide changing from spring tide to neap tide and others as ribbon fish and eel increase their density after quarters of the moon i. e. during the tide changing from neap tide to spring tide. There is no relation existing between the fish and the light of the moon as both full moon and new moon are found to produce same effect upon fishes. The rhythmic change in density is affected simply by physical force of tide which is exogenic. It is wiser to use the phase of moon instead of using sequence of tide as an indicator for fishing.

The density of these fishes also changes rhythmically during twentyfour hours of a day. The lowest density appearing in the night shows that these fishes are most active during the night so they are generally nocturnal and there appears no seasonal variation when fishes are studied together. Seasonal variation exists in different species of fish. The density of black croaker and ribbon fish is usually highest during the day period but that of the eel is usually highest during the vesperal (dusk) period. Black croaker in summer and ribbon fish in spring and winter are diurnal instead of nocturnal as in other seasons. The changing of the black croaker from nocturnal to diurnal in summer seems to be due to the spawning effect, an endogenous influence. If this could be further verified then the exogeneous influence can be overshadowed by endogeneous influence.

The population structure of the observed fishes is contageous and heterogeneous i. e. such fishes are unevenly distributed in different regions of the sea investigated. The degree of variation in density in different locations is usually very great and the density of the same location varies also with the year, the season, the twenty four hours of a day, and with the phases of the moon or sequence of the tide. Such a picture of population as shown by the present investigation will assist to formulate adequate procedure for census sampling which will be a means to simplify the study of heterogeneous contageous populations.

* Called "haul" by the writer.

摘　　要

劉　發　煊

本文係以七艘拖網漁輪漁撈日誌爲依據，以其平均單位漁獲之變化，爲分佈變化，晝夜週期變化及月亮週期變化之準繩。此七艘拖網漁輪，均爲商業性之漁輪，在其漁撈日誌中，均存有不可免之複雜性，因之未採較爲精細之統計方法：

查底棲魚類，大都具有月亮週期性，卽月亮之朔望及上下弦期間，魚羣之密度隨之變化，成循環狀態，此種週期性，不同魚類，亦不相同，在所觀察之魚類中，黑口魚羣之密度自朔望以後逐漸增高，上下弦以後，逐漸降低，帶魚海鰻則反是，其密度自朔望以後，逐漸降低，上下弦以後，逐漸增高，至潮水之變化，係受月亮變化之影響，如就潮水變化言，前者密度之增加在大潮變小潮期間，後者則在小潮變大潮期間，後者密度增高之最高峰，各又不同，帶魚之最高峰，在上下弦前後，接近上下弦(小潮)，而海鰻則在朔望前後，接近朔望(大潮)，帶魚黑口魚羣密度增高之趨勢，雖不相同，而其密度增高之最高峰却均接近上下弦（小潮），二者均爲 210 之主要漁類，故此區之各魚類之綜合表現，大致與黑口相同。

研究動物與月亮之關係，大都重視光之因素，月亮潮水關係密切，概如上述，因之研究海產動物，對於月亮之關係，常感解釋困難，本文之所觀察，認爲魚類之月亮週期性，係由潮水變化之物理力量所致，而與月光無關，因朔望期間，魚類對之常作同等之反應，潮水變化之物理力量，係外在因素，不見有內在因素之存在，雖然，漁民捕魚如以月亮爲標誌，似比以大小潮爲標誌較善，但魚類密度並不均在小潮最高，如海鰻則以大潮爲最高。

所觀察之底棲魚類，亦均具有晝夜週期性，卽在24小時之四階段（晨，晝，昏，夜）中，其密度之變化，亦有循環性之不同，就各種魚類綜合觀之，其密度在晝最高，晨次之，昏又次之，夜最低，無顯著之季節變化，但分別視之，黑口密度除在其他各季節均以晝爲最高外，在夏季則以夜爲最高，帶魚密度，春冬亦以夜爲最高，海鰻密度在春夏則又以昏爲最高，秋冬產量過少，其密度狀況，究竟如何，無從判定。

作者及陳，童二君在 1954 及 1956 年之報告中，曾發現底棲魚類在自然環境之分佈，就密度視之，極不規則，且有季節之變化，今就不同年度之資料觀之，查其與以前所發現大致相同，並有年度變異之傾向，如前所述，同一區內之魚羣密度，又有月亮及晝夜週期性，故此種魚類之族羣構造異常複雜，在此複雜族羣構造未獲悉以前，如作整個族羣密度之分析，似甚困難，如果獲悉以後，似亦需要專司試驗之調查船從事有計劃之樣品採取，方可有濟，此外調查區域，是否爲調查魚類所在之全部？又調查之魚羣是否爲一獨立魚羣？尤須預爲明瞭。

本文所作之分析，僅係依據算學方式平均所得之單位漁獲，其結論之可靠性，或尚有待討論，惟此文觀察之所得，當可對魚類族羣構造作初步之了解，此種了解大有助於採集樣品之設計，適當樣品之採集，當可簡化對於此種魚類族羣密度之推算。

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INDEX TABLE

第一表 黑口、海鰻及帶魚密度隨月齡之變化

Table 1. Density variation of black croaker, ribbon fish and marine eel in accordance with the phases of moon.

月齡 Phase of moon	潮差 Tide	曳網數 No. of haul	黑口 black croaker		帶魚 ribbon fish		海鰻 marine eel		總漁獲 Total catch	
			箱數 No. of box	平均 Average	箱數 No. of box	平均 Average	箱數 No. of box	平均 Average	箱數 No. of box	平均 Average
上弦前三天	2.35m	88	569	6.47	227	2.58	379	4.31	1,838	20.89
上弦前二天	2.26	113	688	6.09	274	2.42	762	6.74	2,649	23.44
上弦前一天	2.03	139	1,127	8.11	245	1.76	832	5.99	3,549	25.53
☽上弦 First quater	1.89	165	1,254	7.60	233	1.41	1,235	7.48	4,142	25.10
上弦後一天	1.73	228	1,567	6.87	698	3.06	1,174	5.15	4,867	21.35
上弦後二天	1.68	257	1,536	5.98	727	2.83	884	3.44	5,196	20.22
上弦後三天	1.84	228	1,087	4.77	1,280	5.61	926	4.06	5,714	25.05
望前三天	2.15	198	1,209	6.11	1,912	9.66	360	1.82	5,356	27.05
望前二天	2.27	159	951	5.98	2,273	14.30	349	2.19	4,824	30.34
望前一天	2.35	128	881	6.88	1,098	8.58	172	1.34	2,955	23.09
○望 Full moon	2.54	103	573	5.56	501	4.86	291	2.83	2,215	21.50
望後一天	2.51	90	433	4.81	806	8.96	533	5.92	2,410	26.78
望後二天	2.51	102	424	4.16	1,119	10.97	530	5.20	2,817	27.62
望後三天	2.36	120	565	4.71	381	3.18	520	4.33	2,501	20.84
下弦前三天	2.23	130	701	5.39	418	3.22	439	3.38	2,437	18.75
下弦前二天	1.89	132	900	6.82	196	1.48	350	2.65	2,641	20.01
下弦前一天	2.02	126	1,117	8.87	390	3.10	200	1.59	2,949	23.40
☾下弦 Third quater	1.81	134	1,593	11.89	611	4.56	191	1.42	3,610	26.94
下弦後一天	1.89	157	1,278	8.14	1,069	6.81	158	1.01	4,309	27.45
下弦後二天	1.83	183	1,019	5.57	868	4.74	150	0.82	4,697	25.67
下弦後三天	1.95	150	597	3.98	1,390	9.27	187	1.25	4,057	27.05
朔前三天	2.16	112	740	6.61	805	7.19	336	3.00	2,925	26.12
朔前二天	2.39	132	805	6.10	771	5.84	485	3.67	3,440	26.06
朔前一天	2.57	113	554	4.90	755	6.68	443	3.92	2,712	24.00
●朔 New moon	2.70	108	712	6.59	347	3.21	471	4.36	2,450	22.69
朔後一天	2.53	86	476	5.53	137	1.59	313	3.64	1,445	16.80
朔後二天	2.63	63	349	5.54	126	2.00	389	6.17	1,134	18.00
朔後三天	2.56	56	281	5.02	99	1.77	492	8.79	986	17.61

第二表　黑口、帶魚及海鰻密度隨晝夜之變化

Table 2. Density variation of black croaker, ribbon fish and marine eel in accordance with the diel periods.

季節 Season	時刻 Diel periods	網數 No. of haul	黑口 black croaker		帶魚 ribbon fish		海鰻 marine eel		總漁獲 Total catch	
			箱數 No. of box	平均 Average	箱數 No. of box	平均 Average	箱數 No. of box	平均 Average	箱數 No. of box	平均 Average
春 Spring	晨 dawn	237	1,422	6.00	390	1.65	1,737	7.33	4,775	18.88
	晝 day	467	3,105	6.65	807	1.73	4,032	8.63	10,416	22.30
	昏 dusk	217	1,283	5.91	246	1.13	1,963	9.05	4,290	19.77
	夜 night	447	2,325	5.20	1,069	2.39	2,175	4.87	7,038	15.74
合計 Total		1,368	8,135	5.95	2,512	1.84	9,907	7.24	26,519	19.39
夏 Summer	晨 dawn	280	1,826	6.52	2,033	7.26	748	2.67	8,605	30.73
	晝 day	567	2,797	4.93	11,696	20.68	1,462	2.58	23,257	41.02
	昏 dusk	267	1,963	7.35	2,347	8.79	804	3.01	7,057	26.43
	夜 night	532	4,011	7.54	1,673	3.14	1,229	2.31	9,865	18.54
合計 Total		1,646	10,597	6.44	17,749	10.78	4,243	2.58	48,784	29.64
秋 Autumn	晨 dawn	111	878	7.91	207	1.86	13	0.12	3,146	28.34
	晝 day	218	2,236	10.26	1,140	5.23	34	0.16	7,243	33.22
	昏 dusk	99	875	8.84	216	2.18	19	0.19	2,049	20.70
	夜 night	193	1,408	7.30	280	1.45	16	0.08	3,429	17.77
合計 Total		621	5,397	8.69	1,843	2.97	82	0.13	15,867	25.55
冬 Winter	晨 dawn	64	309	4.83	29	0.45	7	0.11	1,359	21.23
	晝 day	128	794	6.20	22	0.17	8	0.06	3,346	26.14
	昏 dusk	63	274	4.35	23	0.37	5	0.08	1,057	16.78
	夜 night	106	462	4.36	140	1.32	17	0.16	1,665	15.71
合計 Total		361	1,839	5.09	214	0.59	37	0.10	7,427	20.57
全年 Total Year	晨 dawn	692	4,435	6.41	2,659	3.84	2,505	3.62	17,885	25.85
	晝 day	1,380	9,932	6.47	13,665	9.90	5,536	4.01	44,262	32.07
	昏 dusk	646	4,395	6.80	2,832	4.38	3,791	4.32	14,453	22.37
	夜 night	1,278	8,026	6.42	3,162	2.47	3,437	2.69	21,997	17.21
合計 Total		3,996	25,968	6.50	22,318	5.59	14,269	3.57	98,597	24.67

A LIST OF FISHES FROM PESCADORE ISLANDS

by

K. Y. Chu

The present list consists of 68 families and 180 species, based upon collections mainly made on August, through 13, 1956 by Mr Tsai at Fish markets and coasts of Ma Kun, main town of Pescadore Islands. A small collection was made by the author on March 31, 1956. Among the list of fishes one family and 23 species were not rocorded in Dr. Johnson T. F. Chen's "A Synopsis of Vertebrates of Taiwan" in 1956 and are hereby shown with an "asterisk" in each heading.

1. Orectolobidae
    1. ***Chiloscyllium indicum*** (Gmelin). 510, 530 mm.
2. Galeorhinidae
    2. Mustelus griseus (Pietschman) 400 mm.
    3. Eulamia pleurotaenia (Bleeker). 440 mm.
3. Narcaciontidae
    4. Narcine timlei (Bloch & Schneider).
4. Rhinobatidae
    5. ***Rhinobatos hynnicephalus*** Richardson, 345 mm.
5. Platyrinidae
    6. ***Platyrhina sinensis*** (Bloch & Schneider), 355 mm.
6. Rajidae
    7. ***Raja kenojei*** Müller & Henle, 182, 186, 200 mm.
7. Dussumieriidae
    8. Etrumeus micropus (Temminck & Schlegel), 90, 96 mm.
    9. Spratelloides japonicas (Houttuyn). 62 mm.
    10. Dussumieria hasseltii (Bleeker). 6 specimens. 120, 122, 139, 143, 145, 165 mm.
8. Clupeidae
    11. Sardinella aurita C. & V. 12 specimens.
    12. S. sindensis (Day) 23 specimens
    13. ***Harengula ovalis***, (Bennett) 118.5 mm.
9. Engraulidae
    14. Anchoviella zollingeri (Bleeker), 107 mm.
    15. Anchoviella indica (Van Hasseltt), 89 mm.
10. Synodontidae
    16. Trachynocephalus myops (Bloch & Schneider) 2 specimens, 120, 180 mm.
    17. Saurida tumbil (Bloch). 2 specimens, 115 and 155 mm.
11. Congridae
    *18. Alloconger anagoides (Bleeker). 335 mm.
    *19. Rhynchocymba nystromi nystromi (Jordan & Snyder), 250 mm.

20. Rhynchocymba ectenura (Jordan & Richardson) 335 mm.
21. Anago anago (Temminch & Schlegel). 175 mm.

12. Muraenesocidae
22. Muraenesox cinereus (Forskal). 590 mm.

13. Muraenidae
23. Gymnothorax reticularis Bloch. 370 mm.

14. Fistulariidae
24. Fistularia petimba (Lacepede). 470 mm.

15. Belonidae
25. Ablennes hians (Cuvies & Valenciennes) 405 mm.

16. Hemirhamphidae 230 mm.
26. Hemirhamphus far (Forskal)

*17. Gadidae
*27. Lotella physis (Temminck & Schlegel). 222 mm.

18. Exocoetidae
28. Cypsilurus poecilopterus (Cuvier & Valenciennes). 196 mm.

19. Lophiidae
29. Lophiomus setigerus (Val.). 213 mm.

20. Psettodidae
30. Psettodes erumei (Bloch & Schneider). 397 mm.

21. Bothidae
31. Pseudorhombus arsius (Buchanan-Hamilton), 125, 135 mm.
*32. Engyrosopon kanekonis (Tanaka). 2 specimens, 91, 95 mm.

22. Soleidae
33. Aesopia cornuata Kaup. 3 specimens, 103, 115, 130 mm.

23. Cynoglossidae
34. Cynoglossus robustus Günther 250, 280 mm.

24. Sphyraenidae
35. Sphyraena jello Cuvier & Valenciennes, 115 mm.
36. S. langsar Bleeker, four specimens, 131, 133, 135, 202 mm.

25. Mugilidae
37. Liza carinata (C. & V.) 45 specimens, from 38.5 mm. to 118 mm.
38. Liza macrolepis (Andrew & Smith,=Mugil troscheli Bleeker. 136 mm.
*39. Liza melinopterus (C. & V.). 42 specimens from 26 mm. to 62.5 mm.

26. Atherinidae
*40. Pranesus morrisi (Jordan & Starks)

Atherina morrisi Jordan & Starks, 1906, proc. U. S. N. M. vol. 30, p. 697 (Type locality: Yakushima) .

Head 3.65–3.76; depth 4.75–4.97. Eye 2.47–3.04, in head; snout 3.30–3.96, interorbital space 2.47–2.75; dorsal VI-I, 9–10, A. I. 14–15; scales 43–44.

Jaws equal; the maxillary reaching to below middle of eye; teeth in narrow

bands; eye very large, equal to postorbital part of head. Gill rakers long and slender, 22–25 on lower limb of arch.

Origin of spinous dorsal midway between base of caudal and middle of eye; Pectoral sharply pointed. Insertion of ventrals midway between front of anal and middle of eye; Vent just at tips of ventrals.

Color dusky above with dark points, silver below. A wide lateral band bordered above with a narrow bead-colored stripe. Lateral band entirely covering third row of scales below spinous dorsal and extends across lower angles of second row; its lower edge extends down nearly to middle of fourth row. Snout and tip of mandible black dorsal and caudal dusky; pectoral blackish toward tip; ventrals and anal colorless.

Described from four specimens ranging 91–99 mm. in total length and 74.5–78.6 mm. in standard length.

27. Polynemidae

41. Plydactylus plebejus (Broussonet), 175 mm

*42. Polydactylus sextarius Bloch. 2 specimens, 115, 142 mm.

Polynemus sextarius Weber and de Beaufort, 1922, vol. 4, p. 210 (Kuru).

D. VIII; D. I, 13; A. III, 13; P. 1, 136; L. 1, 47–48;

Height 3.1, Head 3.2. Eye 3.6 in head, covered by a gelatinous membrane. Snout 4.6. Mouth large, reaching far behind eye. Head covered with scales to tip of snout. Anterior and posterior nostrils close together, midway between eye and point of snout. Preoperculum coarsely serrated along its hindborder, the lowermost serrations the longest. Bands of villiform teeth on jaws, no teeth on vomer. Pectoral rays branched with 6 detached rays.

Color yellowish gray. Fins dusky. A large blotch at beginning of lateral line.

28. Holocentridae

43. Holocentrus ruber (Forskal). 3 specimens, 65, 138, 160 mm.

29. Scombridae

44. Rastrelliger chrysozonus (Rüppell). 170mm.

30. Cybiidae

45. Scomberomorus commerson (Lacepede), 115 mm.

31. Carangidae

46. Caranx affinis Rüppell. 73 mm.

47. C. xanthopygus (Cuvier & Valenciennes). 3 specimens, 83, 85, 150 mm.

48. C. equula (Temminck & Schlegel). 142 mm.

49. C. speciosus (Forskal). 65 mm.

50. Elagatis bipinnulatus (Quoy & Gaimard) 320 mm.

51. Alectis indica (Rüppell). Four specimens, 70, 80, 85, 105 mm.

52. Chorinemus totooparah (Rüppell). 4 specimens. 105, 115, 140, 165 mm.

53. Decapterus maruadsi (Temminck & Schlegel). 3 specimens, 85, 95 and 100 mm.

54. D. macrosoma Bleeker. 128 mm.

55. Trachurops crumenophthalmus (Bloch). 3 specimens, 81, 85, 92 mm.

32. Leiognathidae

56. Leiognathus bindus (C. & V.). 2 specimens, 75, 80 mm.

*57. L. berbis (C. & V.). 4 specimens, 49, 70, 74, 75 mm.

58. Gazza minuta (Bloch). 72 mm.

33. Mullidae

59. Upeneus tragula Richardson. 4 specimens, 98, 192, 115 mm.

60. U. bensasi (Temminck & Schlegel). 7 specimens, 101, 102, 102, 108, 115, 115, 160 mm.

*61. Pseudupeneus porphyreus Jenkins. 4 specimens, 88, 95, 103, 115 mm.

Pseudupenus porphyreus Jenkins, 1902 (1903), Bull. U.S. Fish. Comm., vol. 22, p. 454, fig. 22 (type locality: Honolulu).

Depth 3.3–3.5; head 3.0–3.1; Snout 2.1–2.3 in head; eye 3.4–4.0; maxillary reaches 3/4 in snout; barbels reaches opposite preopercle edge; teeth uniserial, conic, short, broad; interorbital 3.4–3.6, broadly convex. Gill rakers 8 23.

Scales 27 in lateral line to caudal base and 2 more on latter, 3 above, 6 or 7 below, 11 to 13 on predorsal.

Dorsal VIII-I, 8; A. II, 6.

Pale olivaceous-brown above, lighter below. Barbels white. On caudal peduncle close behind soft dorsal whitish saddle present, but, obscure in old specimens. Dark brown band along side of snout to eye, then over postocular and upper side of trunk embracing lateral line, fading out below soft dorsal. Also below dark brown streaks starts on cheek then continues back parallel some extent. Dorsal fins brownish, other fins pale white.

62. P. chrysopleuron (T. & S.). 3 specimens, 115, 119, 132 mm.

34. Cepolidae

63. Acanthocepola indica (Day). 320 mm.

35. Apogonidae

64. Apogon quadrifasciatus C. & V. 74 mm.

*65. Apogon fusca (Quoy & Gaimard)

Apogon fusca Fowler & Bean, 1930, U.S.N.M. Bull. vol. 10, p. 59 (Philippine seas).

Head 2.5–2.6. Depth 2.9–3.0. Snout 3.86, eye 2.7–2.8, interorbital 3.8–4.6, postocular portion of head 2.1–2.2; least depth of caudal peduncle 2.8–2.9. Maxillary reaches hind border of pupil; bands of villiform teeth in jaws, on vomer and palatines; preopercle ridge minutely serrate; Gill rakers 6+13.

Scales 23–24 in lateral line to caudal base and 4 or 5 more on latter; 2 above, 6 below, 3–4 predorsal, 2 rows on cheek. Body light brown generally, becoming paler on abdomen. Head largely brownish above. Dark line follows along edge of back along bases of both dorsals. Second narrow dark brown line from above eye anteriorly to upper surface of caudal peduncle, third broad horizontal deep brown band fading out at head but distinctly along side to caudal base. The fourth band beginning above origin of pectoral and ending at base of caudal. At

caudal base and slightly above middle small round black spot, much smaller than pupil and just above tubes of lateral line.

3 specimens from 85 to 88 mm. in standard length.

66. Apogonichthys ellioti (Day). 72 mm

36. Priacanthidae

*67. Priacanthus cruentatus (Lacepede) 95, 140 mm.

37. Acropomidae

68. Acropoma japonicum Günther. 80 mm.

38. Serranidae

69. Cromileptes altivelis (C. & V.). 144, 190 mm.

70. Epinephelus megachir (Richardson). 10 specimens, from 74 mm. to 135 mm

*71. E. rhyncholepis (Bleeker). 140, 250 mm.

72. E. fuscoguttatus (Forskal). 150 mm.

73. E. summana (Forskral). 160 mm.

74. E. awoara (T. & S.). 150 mm.

75. E. diacanthus (C. & V.). 105, 110, 161 mm.

76. E. fasciatus (Forskal). 109 mm.

77. E. fario (Thunberg). 140, 235 mm.

78. E. salmonoides (Lacepede). 158, 265 mm.

79. E. merra Bloch. 175 mm.

80. E. amblycephalus (Bleeker). 280 mm.

81. Cephalopholis pachycentrom (C. & V.) .100, 160 mm.

*82. C. argus (Schneider). 90, 86, 110, 116, and 150 mm.

*83. C. sonnerati (Valenciennes) 290 mm.

84. Variola louti (Forskal). 140, 165 mm.

85. Plectropoma maculatum (Bloch). 150, 160, 190 and 265 mm.

39. Pseudochromidae

86. Dampieria spiloptera (Bleeker). 90 mm.

87. D. melanostigma Fowler. 100, 115, 125 mm.

40. Sciaenidae

88. Argyrosomus nibe (Jordan & Thompson). 248 mm.

89. A. macrocephalus (Tang). 153, 172, 175 and 198 mm.

90. Johnius carutta (Bloch). 194 mm.

91. Sciaena dussumieri (Cuvier & Valenciennes). 184, 187, 189 and 192 mm.

41. Sillaginidae

92. Sillago maculata (Quoy & Gaimard). 145 mm.

42. Girellidae

93. Girella melanichthys (Richardson). 159 mm.

43. Gerridae

94. Gerres japonicus (Bleeker). 105 mm.

95. G. oyena (Forskal). 37.5, 88.5, 89.5, 91, 103 mm.

96. Pentaprion longimanus (Cantor). 80, 85 mm.

44. Sparidae
    97. Argyrops spinifer (Forskal). 126 mm.
    98. Rhabdosargus sarba (Forskal). 97 mm.
45. Lethrinidae
    99. Lethrinus atkinsoni Seale. 92 mm.
    100. L. frenatus Valeniciennes. 51 mm.
    101. L. richardson Günther. 53.5, 63.5, 91, 99 mm.
    *102. L. haematopterus Temminck & Schlegel. 225, 245 mm.
46. Lutjanidae
    103. Lutjanus sebae (Cuvier and Valenciennes). 233 mm.
    104. L. ehrenbergi (Peters). 140, 215 mm.
    105. L. lineolatus (Ruppell). 80 mm.
    106. L. russelli (Bleeker). 52, 64, 139, 184 mm.
    107. L. vitta (Q. & G.). 163 mm.
    108. L. malabaricus (Bl. & Schn.). 395 mm.
    108. Glaucosoma hebraicum Richardson. 265 mm. (=G. burgeri Richardsom)
47. Pentapodidae (Denticidae)
    110. Gymnocranius griseus (Temminck & Schlegel). 239 mm.
    111. Nemipterus japonicas (Bloch). 112, 202 mm.
    112. N. peronii (C. & V.)
48. Caesiodidae
    113. Caesio chrysozonus Cuvier. & Valenciennes 65, 165, 175 mm.
49. Pomadasyidae
    *114. Scolopsis margaritifer (Cuvier). 105, 110, 144, 180 mm.
    115. S. monogramma (Cuvier & Valenciennes). 168 mm.
    116. Pomadasys maculatus (Bloch.) 95 mm.
    117. Plectorhinchus pictus (Thunberg). 232, 250, 340 mm.
    118. Parapristipoma trilineatus (Thunberg). 300 mm.
    *119. Rhoniscus striatus (Gilchrist and Thompson)

Rhonciscus stiatus Smith, 1953, The Sea Fishes of South Africa, p. 259, fig. 680 & Pl. 40, fig. 680 (South Africa).

Depth 2.93–3.04, Head 2.86–3.20. Thickness of the body 1.92–2.22, snout 3.24–3.95, postocular of head 2.19–2.22, width of head 1.84–2.15, least depth of caudal peduncle 2.68–3.17, length of caudal peduncle 1.46–1.87, eye 3.39–3.98, interorbital 3.55–3.80 in head. Maxillary reaching hind nostril; preopercle edge serrate. Gill rakers small, lanceolated, 7–12+13. Scales 58–60 in lateral line to caudal base and 8 to 9 more on latter; 9 scales above lateral line, 13 or 14 below. 38–42 predorsal forward to nostrils, 6–7 transverse series on cheeks.

D. XII, 12–13, 4th spine longest, 1.88–2.19 in head; a notch between spinous dorsal and soft dorsal; first dorsal ray longest 2.79–3.17 in head. Anal with 3 spines and 7 rays, second spine strong and longest, 2.09–2.27 in head. Longest anal ray 2.38–2.54 in head. Pectoral fin 16, lanceolate, 1.50 in head. Caudal

emarginate or a little forked, with 18 rays, 1.44–1.46 in head. No opercular spines.

Dark gray above, silvery white below, with 3 longitudinal stripes, upper following dorsal profile, middle from above oribit follows lateral line to end of soft dorsal where meeting lower, which horizontal from eye to caudal. A blotch on opercles.

Two specimens, 101, 136 mm. in total length and 81.5 and 113.5 mm. in standard length.

The present species was only reported by Barnard at Natal and Delagoa Bay and is the first seen in the region of the Pacific.

50. Theraponidae
    120. Pelates guadrilineatus (Bloch) 110.5, 112, and 117.5 mm.
    121. Therapon jarbua (Forskal). 94, 205 mm.
51. Aplodactylidae
    122. Goniistius zonatus (C. & V.) 215 mm.
52. Pomacentridae
    123. Abudefduf bengalensis (Bloch). 65, 68, 73, 75, 80 mm.
53. Labridae
    *124. Halichoeres amboinensis (Bleeker). 86.5 97, 99, 105, 113.5, 115, 124 mm.
    125. H. centriquadrus (Lac.). 142 mm.
    126. Thalossoma lunare (Linn.). 119, 139 mm.
    127. Hemipteronotus pentadactylus (Linn.). 83, 92, 101, 104, 104 mm.
    128. Anampses coeruleo-punctatus Ruppell. 206 mm.
    129. choerodon azurio (Jordan and Snyder). 175 mm.
    130. C. schoenleinii (C. & V.). Two specimens, 315 mm.
    *131. Bodianus hirsutus (Lacepede). 240 mm.
    *132. Iniistius pavo (C. & V.). 235 mm.
    *133. Cheilinus chlorurus (Bloch). 210 mm.
    134. Cheilio inermis (Forskal). 22, 260, 340 mm.
54. Callyodontidae
    *135. Callyodon rubroviolaceus (Bleeker). 185 mm.
    136. C. dussnmieri (Cuvier & Valenciennes) 6 specimens, 110.5, 121, 169,2 48, 254 mm.
55. Chaetodontidae
    137. Chaetodon lineolatus (Cuvier & Valenciennes) 70, 74,89, 90 mm.
    138. C. colare Bloch, 83, 87, 90, 114, 136 mm.
    139. C. vagabundus Linn. 81 mm.
    *140. C. octofasciatus Bloch. 57, 68, 66, 59, 72 mm.
    141. C. speculum Cuvier and Valenciennes. 67, 88, 94 mm.
    142. C. auriga Forskal. 109 mm.
    143. Microcanthus strigatus (C. & V.). 60'mm.
    144. Holacanthus semicirculatus (C. & V.). 22.5 mm.
    145. Holacanthus septentrionalis Temminck and Schlegel. 148 mm.

56. Acanthuridae

146. Acanthurus dussumieri C. & V.

D. IX, 25–26. A. III, 25–25.

In formalin the color markings all disappeared, leaving the fish uniformly dark brown, with but a trace of the pale white ocular band from behind eye forward around forehead to behind the other eye, and some brown vermiculations on lower side of body.

149, 165, 198 mm.

57. Siganidae

147. Siganus rostratus (Valenciennes). 66, 82, 85, 105, 125, 145, 145 mm.

58. Scorpaenidae

148. Sebastiscus marmoratus (C. & V.). 130, 160 mm.

149. Scorpaenopsis cirrohsa (Thunberg). 170 mm.

150. S. gibbosa (Bloch and Schneider). 90 mm.

151. Brachirus bellus Jordan Hubbs. 50 mm.

152. Apistus carinatus (Bloch and Schneider). 75 mm.

59. Synanceiidae

153. Minous inermis Alcock. 57, 85, 87 mm.

60. Platycephalidae

*154. Inegocia guttata (C. & V.) 270 mm.

155. I. japonica (Tilesius). 129 mm.

156. Platycephalus indicus (Linn.) 230 mm.

157. Cocius crocodila (Tilesius). 129 mm.

61. Triglidae

158. Lepidotrigla japonica (Bleeker). 98, 100, 110 mm.

62. Gobiidae

159. Cryptocentrus papuanus (Peters). 128 mm.

160. Oxyurichthys tentacularis (C. & V.). 50, 54 mm.

161. Parachaeturichthys polynema (Bleeker). 69, 80, 89 mm.

162. Bathygobius fuscus (Rupp.) 43, 58, 60 mm.

163. Glossogobius giuris brunneus (Temminck and Schlegel). 42, 42, 48, 49, 50, 52 mm.

164. Acentrogobius ornatus (Rupp.). 43, 49 mm.

63. Periophthalmidae

165. Periophthalmus cantoensis (Osbeck). 41 mm.

64. Monacanthidae

166. Alutera monoceros (Osbeck). 266 mm.

167. Arotrolepis sulcatus (Hollard). 66 mm.

*168. Monocanthus chinensis (Osbeck). 100 mm.

*169. Stephanolepis cirrhifer (Temminck and Schlegel). 136 mm.

65. Tetraodontidae

170. Fugu ocellatus (Linne.),

171. F. sceleratus (Forster). 100, 126 mm.

*172. Tetraodon sazanami (Tanaka)

Tetraodon sazanami Tanaka, fig. 324, p. 384.

Head 2.33, depth 2.23 in length. Eye 5.0, interorbital 2.31, snout 2.21, depth of caudal peduncle 3.82 in head. Postocular portion of head 2.41. Thickness of body equal the height.

D. 10; A. 11, p. 17, V. o. C. 1, 8, 1.

Body ellipsoid, shortish, dorsal profile a little curved. Head large, interorbital broad, flatish; snout rather short, with steep and concave profile and pointed tip; mouth terminal, rather wide; teeth two in number in either jaw, all subequal, the suture without a deep groove; gill openings not so wide as base of pectoral, curved backward. Dorsal and anal short, with rounded free margin. Caudal broadly rounded. Skin slightly papillose, with fleshy rounded elevations.

Color in formalin dark brown, whitish beneath; several dark, longitudinal undulating lines on belly, interrupted near vent, above anal fin, there are many small whitish spots. All fins except caudale pale.

Described from a specimen of 66 mm. in total length, 50 mm. in standard length.

66. Callionymidae

173. Callionymus schaapii Bleeker. 105, 125, mm.

*174. C. kaianus (Gunther). 105 mm.

67. Parapercidae

175. Parapercis ommatura Jordan and Snyder. 85, 95, 97, 100, 105, 110, 100, 95 mm.

*176. Neopercis xanthozona (Bleeker.) 140 mm.

177. Neopercis sexfasciata (Temminck and Schlegel). 73, 76 mm.

68. Blennidae

178. Omobranchus japonicus (Bleeker). 18 specimens, from 33 mm. to 85 mm.

179. O. kallosoma Bleeker. 36 specimens, from 26 to 60 mm.

*180. Istiblennus zamboangae (Everman and Seale). Total length 124 mm.

Head 4.57 in length; depth 5.58; eye 4.00 in head. D. XII, 21 A. II, 23; lateral line short, ending under the eighth dorsal spine, a distinct nuchal crest present; a fringed tentacle at nostril, five branches with the middle one largest; no posterior canine; dorsal fin slightly incised, and connected by membrane to base of caudal rays.

Color in formalin, dark olivaceous on back and olivaceous on sides; about 5 broad double dark bands down to middle of sides; middle and lower part of side posteriorly with two rows of small roundish black spots, but not very distinct, head dark; dorsal fin black on submargin, below which are short oblique white lines; lower half dark purplish with a series of white blotches along base; anal dark edged, the basal three fourths lighter; caudal mottled with dark; pectorals and ventrals grayish olivaceous.

The above description conforms to Selarias zamboangae Evermann and Seale in every respect except that in the original descripton the nasal tentacle is bifid and lateral line ends under posterior third of dorsal.

摘　　要

朱　光　玉

本文報告之魚類計包括六十八科一百八十種，所用標本大部係由蔡佳發君 1956 年在澎湖所採者，其中一小部係作者所採，註有星記之一科及二十三種，爲臺灣以往無紀錄者。

A PRELIMINARY REPORT ON THE ACTIVITY OF WEN-FISHES (HERRING-LIKE FISHES) ALONG THE COAST OF TAIWAN

by

Liu Fah-hsuen and Shen Shih-chieh

I. INTRODUCTION

The Wen-fishes or Herring-like fishes are the most important food fishes of Taiwan. The fishing ground extends from one to five miles off shore and along all the coast. The production, according to the statistical report of the Taiwan Fishery Production Committee, hes exceeded 20,000 metric tons annually in recent years, ranging more than of any other kinds of fishes. As these fishes have a taste somewhat like that of the sardine of Japan and United states, the local people like to eat them. Moreover, the Wen-fish fishery belongs to the inshore and coastal fisheries the fisherman of which consists 80% of the total fisherman of Taiwan.

Although *Sardinella sindensis* (Day), *Engraulis japonica* (Houttuyn), *Etrumeus micropus* (Temminck & Schlegel), *Sardinella aurita* C & V and *Spratelloides japonicus* (Houttuyn) are the species produced in large quantities they usually take the same habitat with other species of minor importance. Sometimes more than ten species can be caught at the same time and by the same method. It seems necessary to make a general survey on the general activity of these fishes before carrying on further studies on the mentioned individual important species.

The present is a general report on the Wen-fishes of the coast of Pa-tou-tzu, Keelung harbor, Chin-Shan, Tam-Sui, and the various places of Peng-Hu such as the East shore, the Peng-Hu bay and Mao-Yü where the establishment of stations is found to be available at present (fig. 1.).

The authors wish to express deep appreciation and thanks to Dr. Moltze Y. H. Wang, Chairman of the Department of Zoology and to Mr. K. Y. Chu, Instructor of the Department of Zoology for lending important references.

II. THE FISHERY OF WEN-FISHES

The Wen-fish fishery is still undeveloped although the production of this kind of fish has been increasing during the recent years. This is probably due to the lack of adequate fishing method for the catching of the important species. The general picture of the fishery is as follows:

1. Previous research.

Not much ecological work can be found besides some taxonomical reports. However, there are some technological woks by the Japanese Yosikosi, 1936 and Shen, 1955.

Technological experiments started early in 1905 in which the purse seine was tried for catching these fishes at Peng-Hu. In 1906, the processing methods as methods of sun-drying and brine boiling were experimented. A general survey for these fishes along the coasts of the islands of southern Taiwan was carried out in 1910 and it was found that the Wen-fishes were very abundant. For the solving of the bonito-bait, the culture of these fishes was tried in 1913 and in 1915 fishing by torch-light net was experimented with. Such fishing and processing methods were also experimented at the northern fishing ports such as Yilan and Su-Ao in 1919 and hereafter no further work of this kind can be found.

2. The kinds of Wen-Fishes.

There are five Families 15 Genus and 38 species of these fishes in Taiwan, of which only 33 species being collected. It is found that 6 of the 33 species are not reported to have inhabited the area of Taiwan formerly.

(1). **Family: Albulidae.**

Genus: *Albula* Gronow 1763.

1. **Albula vulpes* (Linnaeus).

(2). **Family: Dorosomatide.**

Genus: *Clupanodon* Lacepede, 1803.

2. *Clupanodon thrissa* (Linnaeus).

Genus: *Konosirus* Jordan et Snyder, 1900.

3. *Konosirus punctatus* (Temminek and Schlegel).

Genus: *Nematalosa* Regan, 1917.

4. *Nematalosa nasus* (Bloch).

(3). **Family: Dussumieridae.**

Genus: *Etrumeus* Bleeker 1853.

5. *Etrumeus micropus* (Temminck & Schlegel).

Genus: *Spratelloides* Bleeker, 1852.

6. *Spratelloids japonicus* (Houttuyn).

Genus: *Dussumieria* C & V. 1847.

7. *Dussumieria acuta* C. & V.

8. *Dussumieria hasselti* Bleeker.

(4). **Family: Clupeidae.**

Genus: *Sardinella* C. & V. 1847.

9. *Sardinella aurita* C. & V.

10. *Sardinella sindensis* (Day).

11. *Sardinella melanura* (cuvier).

12. *Sardinella jussieu* (Lacepede).

13. *Sardinella sirm* Valbaum.

14. *Sardinella brachrsoma* (Bleeker).

Genus: *Ilisha* Richardson, 1846.

production of these fishes is due to the increase at this fishing port. Taipei-hsien is the place of next importance and its annual production exceeds 5,000 metric tons. Yilan, Kaohsiung and Hsin-tsu-hsien and the cities of Keelung, Kaohsiung, Tainan produce more than 500 metric tons annually. Other places producing Wen-fishes have annual production of less than 500 metric tons (table 2).

4. The fishing ground and fishing season of Wen-fishes.

The fishing grounds are indicated in figure 1. It is found that almost all along the coast of Taiwan yields Wen-fishes. However, there are special areas where they are found to be highly concentrated. In the north, they are found to concentrate in the following three areas: (1) The area from Bi-Tao-Chiao to chin-shan. (2) The area from Bi-Tao-Chiao to Shan-Chao-Chiao. (3) The area from Shan-Chao-Chiao to Su-Ao. In the south, thre are four such areas namely: (1) The area from Tainan to Kaohsiung, (2) The area from Tung-Kang to Fong-Shan, (3) the area along the east coast of Peng-Hu and (4) the area between Mao-Yü and the Formosa bank. This last fishing center of southern Taiwan has been exploited only in the recent years.

The fishing seasons of these fishes is generally from March to October. Small Quantities are caught by set nets and by weirs at some places in other months of the year. It is difficult to say whether they can be caught in large quantities during the months from November to February because then the fisherman do not usually fish for them, due to the roughness of the sea caused by the monsoon and on the other hand there are other kind of fishes such as the mullet, the spear-fish, bonito, mackerel and the seabream etc. which can be fished with a higher profit.

5. The Fishing methods of Wen-fishes.

The fishing methods of these fishes are numerous in Taiwan. The more important ones are the torch-net-fishing, the set-net-fishing, the beach seining, the swing-bell-fishing and the purse seining, The construction of the gear and the method of operation of these methods weae described in details by Yasuhara in 1941-1942. A brief Chinese report has been presented in 1955 by the writer. These methods are used at different places as follows:

(1) The torch-net-fishing is perhaps the most important method engaged in this fishery. It is used almost at all fishing places but rather in larger scale at Peng-Hu Hsien, Pa-tou-tzu and Kaohsiung city.

(2) The beach seining is also employed at all fishing places especially at Peng-Hu, Yilan, Taipei and Hsin-tsu Hsien.

(3) The set-net-fishing is more practiced at Yilan and Taipei Hsien.

(4) The purse seining is only used at Kaohsiung, Yilan, Taipei, Peng-Hu and at Keelung.

(5) The swing-bell fishing is especially practiced at the Keelung harbor.

III. MATERIAL AND METHOD

The method of interpreting the activities of these fishes is by finding from the fish composition, their presence at different places and in different seasons. Four

第二表　臺灣各地1936及1

Table II. The Production of Her

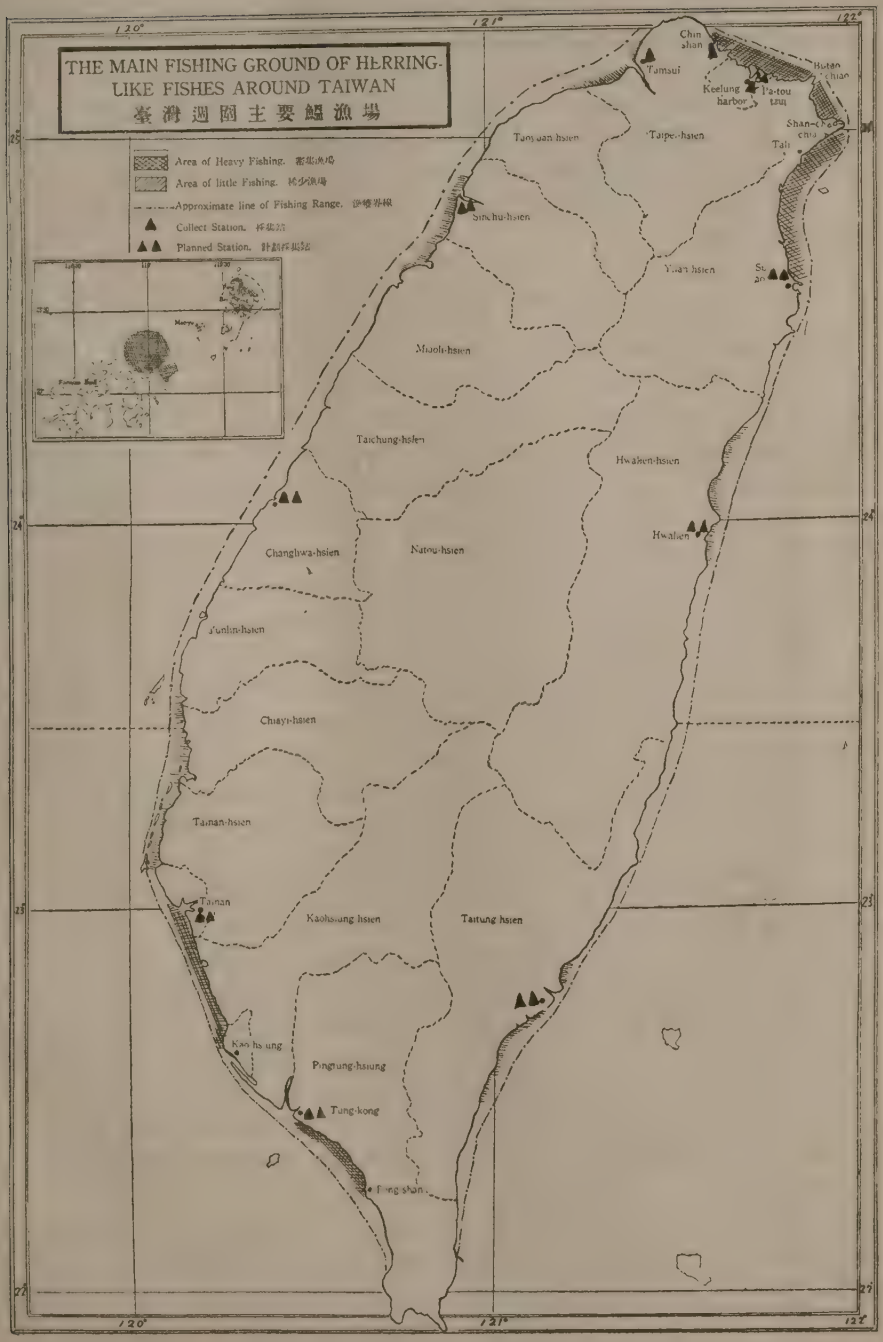
Year 年別 / Production 產量 / Locality 縣市別	1936		1945		1946		1947		1948		1949	
	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	百分
Taipei-Hsien 臺北縣	7,351	67.84	3,022	66.03	2,986	46.29	5,345	51.29	5,879	44.58	5,535	52
Yilan-Hsien 宜蘭縣	—		—		—		—		—		—	
Taoyuan-Hsien 桃園縣	—		—		—		—		—		—	
Sinchu-Hsien 新竹縣	663	6.12	256	55.93	1,075	16.66	134	1.38	1,284	9.75	1,284	12
Miaoli-Hsien 苗栗縣	—		—		—		—		—		—	
Taichung-Hsien 臺中縣	81	0.84	875	19.12	647	10.03	218	2.28	260	1.99	180	1
Changhwa-Hsien 彰化縣	—		—		—		—		—		—	
Nantou-Hsien 南投縣	—		—		—		—		—		—	
Yunlin-Hsien 雲林縣	—		—		—		—		—		—	
Chiayi-Hsien 嘉義縣	—		—		—		—		—		—	
Tainan-Hsien 臺南縣	67	0.62	4	0.09	5	0.08	39	0.48	40	0.5	43	0
Kaohsiung-Hsien 高雄縣	473	4.37	138	3.02	387	5.91	908	8.82	1,313	9.95	822	7
Pingtung-Hsien 屏東縣	—		—		—		—		—		—	
Taitung-Hsien 臺東縣	67	0.62	2	0.04	37	0.57	38	0.36	153	1.18	127	1
Hwalien-Hsien 花蓮縣	16		1	0.02	16	0.24	7	0.07	61	0.48	107	1
Penghu-Hsien 澎湖縣	2,116	19.53	264	5.77	1,275	19.76	1,079	10.58	998	7.68	1,595	15
Keelung-City 基隆市	—		—		8	0.12	2,522	24.55	3,120	23.68	899	8
Tainan-City 臺南市	—		10	0.22	13	0.2	2	0.02	7	0.06	12	0
Kaohsiung-City 高雄市	—		6	0.13	4	0.06	16	0.15	32	0.28	10	0
Total 總計	10,834	99.94	4,578	99.96	6,453	96.74	10,308	99.99	13,147	99.97	10,614	100

945—1956年鰛魚產量

rring-like Fishes by Locality.

	1950		1951		1952		1953		1954		1955		1956	
% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比	Metric tons 公噸	% 百分比
.15	2,345	37.70	5,920	44.29	5,259	35.74	4,246	40.87	5,315	23.80	5,743	23.47	5,131	20.41
	1,185	19.05	1,140	8.53	2,769	18.82	795	7.65	1,697	7.60	2,425	9.91	1,459	5.80
	29	0.47	22	0.16	411	2.79	234	2.25	124	0.55	103	0.42	123	0.48
.10	333	5.35	534	3.99	861	5.85	587	5.65	386	1.72	433	1.76	456	1.81
	154	2.48	496	3.71	439	2.98	333	3.20	420	1.88	508	2.07	260	1.03
.70	79	1.27	186	1.39	123	0.83	97	0.93	153	0.68	160	0.65	180	0.71
	48	0.77	64	0.48	51	0.34	47	0.45	53	0.23	150	0.61	101	0.40
	—		—		—		—		—		—		—	
	3	0.05	29	0.22	25	0.16	25	0.24	32	0.14	60	0.24	58	0.23
	1	0.02	12	0.09	15	0.10	24	0.23	73	0.32	23	0.09	3	0.01
.41	68	1.09	14	0.10	22	0.14	144	1.38	118	0.52	162	0.66	126	0.49
.74	311	5.00	716	5.36	1,002	6.81	511	4.91	548	2.45	729	2.97	504	2.00
	141	2.27	203	1.52	364	2.47	81	0.77	235	1.05	350	1.43	185	0.72
.19	66	1.06	153	1.14	392	2.66	199	1.91	388	1.74	485	1.98	433	1.71
.01	88	1.41	60	0.45	26	0.17	163	1.56	101	0.45	308	1.25	261	1.03
.03	619	9.95	2,577	20.83	2,281	15.50	2,261	21.76	11,263	50.44	11,697	47.80	14,010	55.75
.47	722	11.61	982	7.34	648	4.40	550	5.29	1,216	5.44	805	3.28	748	2.97
.11	28	0.45	42	0.31	16	0.10	64	0.61	144	0.64	168	0.68	504	2.00
.09	—		216	1.61	7	0.05	28	0.26	60	0.26	150	0.61	587	2.33
.00	6,220	100.00	13,366	100.00	14,711	99.91	10,389	99.92	22,326	99.91	24,469	99.88	25,129	100.00

Fig. I


THE MAIN FISHING GROUND OF HERRING-LIKE FISHES AROUND TAIWAN
臺灣週圍主要鰮漁場
Area of Heavy Fishing. 密集漁場
Area of little Fishing. 稀少漁場
Approximate line of Fishing Range. 漁場界線
Collect Station. 採集站
Planned Station. 計劃採集站
120°
121°
122°
25°
24°
23°
22°
Chin shan
Tamsui
Keelung harbor
Pa-tou tsui
Tanyuan-hsien
Taipei-hsien
Tali
Sinchu-hsien
Yuan-hsien
Miaoli-hsien
Taichung-hsien
Hwalien-hsien
Hwalien
Changhwa-hsien
Natou-hsien
Yunlin-hsien
Chiayi-hsien
Tainan-hsien
Tainan
Kaohsiung hsien
Taitung hsien
Kaohsiung
Pingtung-hsiung
Tung-kong
Fengshan

stations have been established at nothern Taiwan, the Keelung harbor, Tamsui, Chin-Shan and Pa-tou-tzu since 1955 and in 1957 a station was established at Peng-Hu where samples are taken at three various places, the Peng-Hu Bay, the eastern coast and Mao-Yü. Samples are taken on the 15th and on the 30th of each month and the percentage of different species is calculated. The sampling is made by piling up the catches of the fishing boat of the day into a triangular heap and by taking a double handful of fishes from each angle. The fishes which are taken from the angles are mixed together as one sample and are checked with x^2 test, the result of which is $P=0.10$ or $P>0.10$.

IV. OBSERVATION

Table 3 presents the monthly catch of the Wen-fishes of various places in percent. The species which are listed in the bable possess record of catch over one percent. It is clearly indicated that the Wen-fishes do have regional, monthly and yearly variations although as it has been stated previously they usually take the same habitat.

By locality, they are not all found at all the places investigated. Some of them have a wider range of distribution than others. *Etrumeus mieropus* and *Sardinella aurita* have the widest range of distribution. They are found at all the investgated places although the former seems more abundant at Pa-tou-tzu, Chin-shan, Tam-sui and Moa-Yü than at other places and the later seems more abundant at Pa-tou-tzu and Peng-hu Hsien, especially at Mao-yü. Those that have a narrower range of distribution are: (1) *Spratelloides japonicus* is not found at Tam-sui and Mao-yü but very abundant at Pa-tou-tzu, Keelung harbor and the east coast of Peng-hu, (2) *Sardinella sindensis* is not found at Pa-tou-tzu, Chin-shan and Mao-yü but is rather abundant at Peng-hu Bay and Keelung harbor, (3) *Sardinella jussieu* is not found at Mao-yü and is very rare at other places with the exception of Tam-sui and Peng-hu bay, (4) *Engraulis japonica* is not found at Mao-yü and seems more abundant at Pa-tou-tzu, Chin-shan and Tam-sui, (5) *Stolephorus zollingeri* is not found only at Keelung harbor and Mao-yü but is abundant at Pa-tou-tzu, Tam-sui and East coast of Peng-hu, (6) Stolephorus pseudoheterolobus is only found at Tam-sui, east coast of Peng-hu and Peng-hu bay and is only abundant at Peng-hu bay. Others are distributed in the narrowest rang as they are only found at Tam-sui although the Ilisha indica is represented only by its fry. The variation of the range of distribution has made some of the investigated places to possess more species than the other e. g. Tamsui possesses all the fourteen species that have the record of catch of more than one percent and Mao-yü possesses only two valuable species the *Etrumeus micropus* and the *Sardinella aurita.*

Yearly variation is also found to exist among them. Some, as the *Spratelloides japonicus* is very abundant at Pa-tou-tzu in 1955 and 1956 and at Keelung harbor in 1956 but absent at the former place in 1957 and at the latter in 1955 and in 1957. Many other species also show such a phenomenon at one place or at the other. Very

第三表　各站鱵類每月產量百分比

Table 3. Monthly catch of the Herring-like fishes at various stations in percent.

Locality 地名 / Name of species 種名	Year 年	Month 月	Pa-tou-tzu 八斗子 I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Keelung Harbor 基隆港 I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Chin-Shan 金山 I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Tam-Sui 淡水 I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Atoulo valiens 長頜鱵	1960																																																
	1959																																																
	1958																																															
Nematolosa nasus 鬚鼻水鱵	1960																																															
	1959																																															
	1958																																															
Etrumeus micropus 長吻鱵	1960				2.95	67.41	97.97	64.14	1.58																																								
	1959						64.50	15.53	4.21								1.15	4.42																															
	1958						68.98		10.31									10.48																															
Spratelloides japonicus 日本鱵	1960				100.00	97.05	31.85				90.94	3.40	100.00																																					
	1959					100.00	100.00	27.00	40.77	1.56		0.84	9.62				79.19	75.17	80.74																															
	1958																																																
Sardinella aurita 黃小沙丁	1960							31.71	14.28																																								
	1959							33.98	3.15									4.44																															
	1958						4.22	100.00	10.31																																									
Sardinella sindensis 星點小沙	1960																																															
	1959																27.51	12.31	9.24	95.83																												
	1958																					33.33	100.00	100.00																									
Sardinella jussieu 遮氏小沙	1960																																															
	1959							2.91	8.42				0.31						0.42	4.17													4.31															
	1958																		9.18		33.33																											
Jenkinsia lamprotaenia 白腹鱵	1960																																															
	1959																																															
	1958																																															
Engraulis japonica 日本鱵	1960				0.74	2.03	13.17	84.12	9.06	77.27									6.58	55.90		0.69							2.21	2.92	3.77	3.05	54.53															
	1959					3.06	9.76	76.84	100.00	93.53	42.85	2.00				1.53	0.44												0.38	13.23	22.41																	
	1958					32.39		79.31	65.75	100.00									80.34		33.32																											
Stolephorus tri 三式前甲鱵	1960																																															
	1959																																															
	1958																																															
Stolephorus pseudoheterolobus 假異甲前鱵	1960																																														
	1959																																															
	1958																																															
Stolephorus zollingeri 正式前甲鱵	1960							0.96		19.31																																						
	1959					0.50		6.31		5.61	46.89	98.00																																					
	1958								34.28																																								
Thrissocles dussumieri 短式棘鱵	1960																																															
	1959																																															
	1958																																															
Thrissocles setirostris 長鼻棘鱵	1960																																															
	1959																																															
	1958																																															
Thrissocles hamiltonensis 干多棘鱵	1960																																														
	1959																																															
	1958																																															
* Others 其他	1960																																															
	1959																																															
	1958																																															

Locality 地名 / Name of species 種名	Year 年	Month 月	Peng-Hu Hsien 澎湖縣 East Coast 東岸 I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Peng-Hu Bay 澎湖灣 I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mao-Yü 貓嶼 I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Atoulo valiens 長頜鱵	1960																																								
	1959																																								
	1958																																							
Nematolosa nasus 鬚鼻水鱵	1960																																							
	1959																																							
	1958																																							
Etrumeus micropus 長吻鱵	1960																																							
	1959																																							
	1958																																							
Spratelloides japonicus 日本鱵	1960																																							
	1959																																							
	1958																																							
Sardinella aurita 黃小沙丁	1960																																							
	1959																																							
	1958																																							
Sardinella sindensis 星點小沙	1960																																							
	1959																																							
	1958																																							
Sardinella jussieu 遮氏小沙	1960																																							
	1959																																							
	1958																																							
Jenkinsia lamprotaenia 白腹鱵	1960																																							
	1959																																							
	1958																																							
Engraulis japonica 日本鱵	1960																																							
	1959																																							
	1958																																							
Stolephorus tri 三式前甲鱵	1960																																							
	1959																																							
	1958																																							
Stolephorus pseudoheterolobus 假異甲前鱵	1960																																							
	1959																																							
	1958																																							
Stolephorus zollingeri 正式前甲鱵	1960																																							
	1959																																							
	1958																																							
Thrissocles dussumieri 短式棘鱵	1960																																							
	1959																																							
	1958																																							
Thrissocles setirostris 長鼻棘鱵	1960																																							
	1959																																							
	1958																																							
Thrissocles hamiltonensis 干多棘鱵	1960																																							
	1959																																							
	1958																																							
* Others 其他	1960																																							
	1959																																							
	1958																																							

* Include all scarce species which only in one or two months, the percentage of those are below 0.10.
包括其有在百分比低于0.10的稀種，且在出現一個或二個月。

few *Thrissocles dessumieri* appeard in 1955 but they were more abundant in other years at Tamsui.

The monthly variation of these fishes is rather complicated. The same species of Wen-fishes may: (1) appear early at one place and late at other places for example, the *Spratelloides japonicus* appears as early as February at Pa-tou-tzu but late as in July at Chin-shan, (2) appears early in one year and late in another year and at the same place, for example, the *Engranlis japonica* appeared in April in 1955 but in May in 1956 and 1957 at Pa-tou-tzu while at Tamsui, it appeared in March in 1955 and 1957 but in April in 1956 and (3) appeared more in one month and less at another month at the same place as is most clearly shown by the *Engraulis japonica* at Pa-tou-tzu in 1956 in rather a gradational manner (May 3.00%, June 9.70%, July 76.84%, August 100.00%, September 93.53%, October 42.85% and November 2.00%). Different species also appear differently at times at the same place and at different places e. g. at Tam-sui, the *Engraulis japonica*, the *Etrumeus micropus* and the *Stolephorus zollingeri* etc. may appear as early as in March but others like the *Sardinella jussieu* and *Nematalosa nasus* do not appear earlier than April, the *Stolephorus tri* and *Thrissocles kammalensis* do not appear earlies than May and the *Sardinella sindensis* do not appear earlier than July; the *Spratelloides japonicus* appears early in Febrary at Pa-tou-tzu, no other species appears so early at other places.

V. SUMMARY

1. The Wen-fishes are the most important commercial fishes of Taiwan because their production is higher than that of any other commercial fishes, the local people like to eat them and about 80% of the local fishermen are connected to the fishery of these fishes. They are fished by many kinds of methods and the main methods are torch-net-fishing and various kinds of seining.

2. Samples of thirty-three species have been collected and six of them are found not having been reported to inhabit the sea along the coast of Taiwan.

3. These fishes can be found all along the coast of Taiwan, but they are concentrated in particular areas. The fishing season is found to be from March to October but it is unable to conclude whether they can be caught in large quantities in other months of the year.

4. The range of distribution of these fishes is not all the same. have a very wide range of distribution being found at all the investigated stations and some have a narrower range of distribution being found at some station and not at an other or others. Some of them have a very narrow range of distribution being found one or two stations.

5. The distribution of these fishes also varies with the month and the year. Some may be present in one year and absent in another year and some may be very abundant at a place in one year and few in another year. The monthly variation is rather complicate. Sometimes the same species of fish may appear early at one place and

late at another place and sometimes at the same place it may appear early in one year and late in another year or it may appear in different months of the year in different quantity. The different species also appear differently in times at the same place and at different places.

摘　　要

劉　發　煊　　沈　世　傑

臺灣鰹類產量比其他任何經濟魚類之產量爲高，且爲本省居民所嗜食之魚類。經營此種漁業之漁民約佔全省漁民總數之80%採捕此種魚類之方法甚多，惟其至要者爲焚寄網及各種圍網，本省所產種類經採集到者已達三十三種，其中有六種爲臺灣以往無紀錄。

此種魚類之分佈範圍不盡相同，有者在各調查區，均有發現有者則僅可于數調查區發現，甚而更有者僅限于一或二調查區有之。其出現有年度月別之不同，有者於同一地區某年出現則他年無，或某年多而他年少，亦有同一種類於不同地區，出現有早遲之別，甚而於同一地區某年早而他年遲，或某月多而另月少，不同種者於同一地區或不同地區更有出現早遲不同之現象。

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A THIRD REPORT ON THE STUDY OF THE BLACK CROAKER (ARGYROSOMUS NIBE J. & T.) OF THE NORTHERN TRAWLING GROUND OF TAIWAN

by

LIU FAH-HSUEN and CHEN GIN-CHEN

The study on the black croaker of the North trawling ground of Taiwan has been started since 1953. The first report was published in 1954 (1) and the second was published in 1956 (2). By using the same method and the same source of material the writer presents this third report of his study.

THE LENGTH FREQUENCY DISTRIBUTION

The monthly variation of the length frequency distribution showed little difference in 1956 as compared with that of the previous years. However, there exists some difference in the yearly distribution (fig, 1). It has been found that the percentage of various frequency of body length is not the same as that observed in previous reports.

THE AGE COMPOSITION

The age composition is illustratrated in table 1 and fig. 2. It is remarkable that the individuals with scales of one annulus compose 61% of the total and that of the two annuli is only 30% while those of three annuli and more remain at less than 8%.

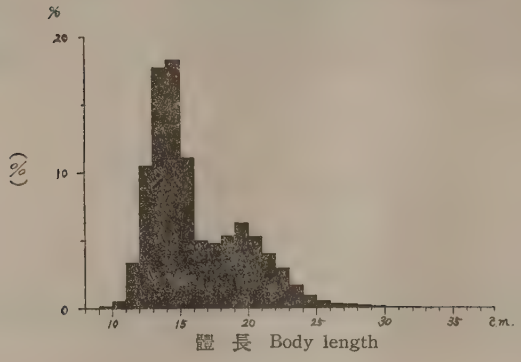
THE TOTAL CATCH

The total catch of 1955 was 398,188 boxes and that of 1956 was 395,280 boxes, the black croaker was only 111,064 boxes and 85,890 boxes respectively (tables 2 and 3). The amount of the catch of the black croaker varied with months and with fishing districts. In 1955, the black croaker was caught mostly in June (19,821 boxes) and in March (15,057 boxes); in district 210 (74,915 boxes) and in district 219 (24,599 boxes). In 1956, it was caught mostly in December (17,281 boxes) and in November (11,675 boxes); in district 210 (46,662 boxes) and in district 219 (37,270 boxes).

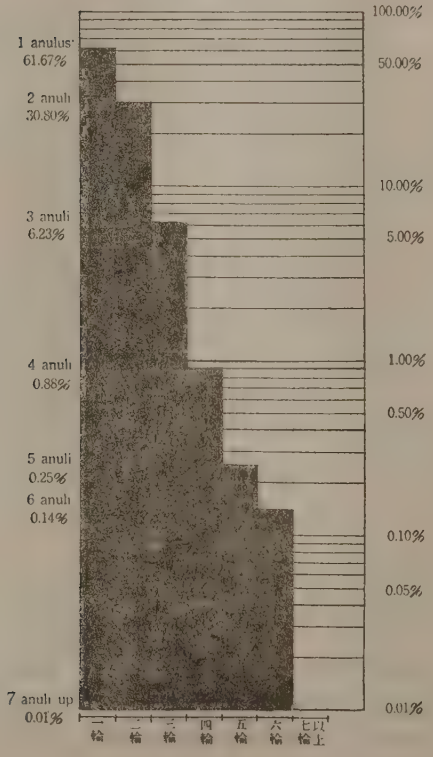
THE CATCH PER HAUL

The catch per haul is also illustrated in tables 2 and 3. In 1955, the annual average is 6.45 boxes. As to the variation by month it reached as high as 8.71 boxes in June and 10.07 boxes in March. The record of 8.73 boxes in district 219 has been found to be the highest. Only 7.50 boxes appeared in district 210 and those that yielded more than 5 boxes were the districts 200, T. 388 and 277. In 1956, the annual average was 4.98 boxes and the thighest record was found in December (11.88 boxes) and in

第一圖　1956年體長組合
Fig. 1. Length freguency distribution in 1956.



第二圖　1956年齡組合
Fig. 2. Age composit5ion in 1956.



第一表 1956 年間體長組合及年齡組合

Table I. Length Frequency Distribution & Age Composition in 1956

時間 Time / % / 體長 Length in c.m.	1956 一月 Jan.	二月 Feb.	三月 Mar.	四月 Apr.	五月 May.	六月 June	七月 July	八月 Aug.	九月 Sep.	十月 Oct.	十一月 Nov.	十二月 Dec.	年間體長組合 Length frequency of the year	年輪數 No. of anulus	百分比 %	前報告之百分比 Percentage of previous report 第二次報告 Second report	前報告之百分比 Percentage of previous report 第一次報告 First report
10								0.26	0.28	0.77	0.41		0.14				
11	0.49		0.37						1.97	2.08	1.24		0.51				
12		0.17	2.62	0.45	0.11			0.52	14.76	9.64	10.53	1.58	3.37				
13	6.35	2.82	16.47	6.59	0.34			0.52	29.14	25.40	25.02	13.75	10.54	I	61.67	56.61	55.03
14	18.06	13.91	30.32	15.12	1.03			1.55	27.91	30.39	31.87	42.38	17.71				
15	39.57	41.56	36.31	29.80	5.38	0.30		1.03	8.08	10.90	16.35	31.34	18.34				
16	26.85	31.96	9.00	27.70	10.41	2.44		1.81	5.26	5.11	5.24	6.99	11.06				
17	4.42	6.31	1.20	9.13	13.39	11.19	0.38	4.65	3.20	2.99	1.61	1.13	4.97				
18	0.49	1.18	0.07	1.10	8.12	19.33	4.21	17.05	1.22	2.80	1.49	0.50	4.80				
19	1.10	0.50	1.00	0.50	3.78	15.85	13.15	20.67	1.88	2.70	2.56	0.61	5.36				
20	0.39	0.22	0.69	1.76	10.18	12.22	19.16	24.03	1.69	2.60	1.98	0.73	6.30	II	30.80	38.81	35.21
21	1.07	0.20	0.67	3.23	14.42	9.78	16.35	12.66	1.69	2.60	1,16	0.44	5.36				
22	0.76	0.55	0.79	2.60	12.47	7.41	12.90	7.49	1.60	1.06	0.21	0.30	4.01				
23	0.24	0.31	0.34	1.28	9.50	7.63	11.11	3.88	0.38	0.58	0.21	0.14	2.97				
24	0.15	0.10	0.07	0.10	3.66	5.19	9.20	2.07	0.09	0.19	0.08	0.06	1.75				
25		0.08	0.04	0.08	1.95	2.37	4.85	1.03	0.66	0.19		0.04	0.94	III	6.23	3.98	8.42
26		0.03		0.08	0.69	2.44	2.81	0.52	0.19			0.03	0.57				
27	0.03	0.03		0.27	1.26	1.26	1.53				0.04		0.37				
28	0.00	0.03			1.26	0.81	1.66						0.31	IV	0.88	0.48	0.90
29	0.00	0.02	0.01	0.03	0.69	0.89	0.77						0.20				
30		0.02		0.03.	0.34	0.89	0.64						0.16				
31	0.00				0.23								0.02	V	0.25	0.09	0.34
32	0.00			0.08	0.23		0,51						0.07				
33				0.03	0.34		0.51	0.26					0.10				
34					0.23		0.13						0.03	VI	0.14	0.02	0.08
35							0.13						0.01				
36				0.02									0.00	VII & VIII	0.01	0.01	0.03
37				0.02									0.00				
測定尾數 No. of tails examined	321	674	473	822	695	628	783	386	425	356	626	592	合計 Total 6.781			合計 Total 78.47	合計 Total 8,920

第二表 1955 年 19 艘拖網漁船作業分析表

Table II. Analysis on Operations of 19 Trawlers in 1955

漁區 Distria / 月份 Month		200	210	217	218	219	273	274	275	277	279	280	284	288	289	388	S	T	C	合計 Total
一月 Jan.	* a	3	484			32			46	27		3		2			54	33		684
	b	112	11,419			836			1,007	809		23		24			1,534	632		16,405
	c		2,754			294			268	497							651	309		4,773
	d		5.69			9.19			5.83	18.41							12.06	9.36		6.98
二月 Feb.	a		49	52	195	6			655	68	3	21	43	60	5	40	141	28	71	1,437
	b		1,015	777	3,797	280			13,205	1,371	62	263	1,982	1,957	79	1,439	2,812	844	3,194	33,077
	c		393	55	532	182			3,035	79	2	9			35	779	374	575	122	6,172
	d		8.02	1.06	2.73	30.33			4.63	1.16	0.67	0.43			7.00	19.48	2.65	20.54	1.72	4.30
三月 March	a		431	2	255	389			85	14		5	21	52		25	89	30	97	1,495
	b		10,025		3,724	12,749			1,051	255		57	217	861		348	1,612	461	1,867	32,227
	c		4,676		462	9,454			142	46			13	44		30	154	6	30	15,047
	d		10.85		1.81	24.30			1.67	3.29			0.62	0.85		1.20	1.73	0.20	0.31	10.07
四月 Apr.	a	27	1,409	30	65	109	98	11	150	13			2	38		73	74	19		2,118
	b	494	31,777	450	1,233	2,310	2,443	279	2,280	188			5	686		1,088	1,170	325		44,728
	c	177	10,701	17	370	1,219	79	13	215	25						128	103	44		13,091
	d	6.56	7.59	0.57	5.69	11.18	0.81	1.18	1.43	1.92						1.75	1.39	2.32		6.18
五月 May	a	63	1,976		9	256	41	3	33							6	27			2,414
	b	1,474	38,799		128	5,542	1,183	27	405							54	249			47,861
	c	450	8,993		32	14,912	70		13								21			11,491
	d	7.14	4.55		3.56	7.47	1.71		0.39								0.78			4.76
六月 June	a	6	2,017		8	223			16					3		3				2,276
	b	147	54,174		97	6,138			187					25		44				60,812
	c	63	18,233		2	1,523														19,821
	d	10.50	9.04		0.25	6.83														8.71
七月 July.	a		1,140			87														1,227
	b		40,878			2,932														43,810
	c		8,225			545														8,770
	d		7.21			6.26														7.15
八月 Aug.	a		532			100														632
	b		19,000			2,269														21,169
	c		4,184			598														4,782
	d		7.86			5.98														7.37
九月 Sep.	a		499		6	139	2		6			24					59	21		750
	b		12,445		54	4,367	51		136			437					902	568		18,960
	c		2,346			378	2													2,726
	d		4.70			2.72	1.00													3.61
十月 Oct.	a	13	678		9	68				6	8	49					242	21		1,094
	b	334			95	1,461				230	133	858					4,238	394		7,742
	c	141	6,839			325				9							438	8		7,760
	d	10.85	10.09			4.78				1.50							1.81	0.39		7.09
十一月 Nov.	a		546		44	603			43							16	38	9		1,299
	b		14,701		652	14,292			636							157	568	184		31,190
	c		6,444		5	3,942			51							2	13	47		10,504
	d		11.80		0.11	6.54			1.19							0.13	0.34	5.22		8.09
十二月 Dec.	a	3	228		41	807			139			8	17	16	21	17	358	14	112	1,781
	b	49	4,698		564	18,089			2,948			125	532	209	375	370	8,258	318	2,521	39,056
	c	3	1,127		14	4,227			139						16	5	532	54		6,117
	d	1.00	4.94		0.34	5.24			1.00						0.76	0.29	1 49	3.86		3.43
合計 Total	a	115	9,989	84	632	2,819	141	14	1,173	128	11	110	83	171	26	180	1,082	175	280	17,213
	b	2,610	238,931	1,227	10,344	71,315	3,677	306	21,855	2,853	195	1,772	2,736	3,762	454	3,500	21,343	3,726	7,582	398,188
	c	834	74,915	72	1,417	24,599	151	13	3,863	656	2	9	13	44	51	944	2,286	1,043	152	111,064
	d	7.25	7.50	0.86	2.24	8.73	1.07	0.93	3.29	5.13	0.18	0.08	0.16	0.26	1 96	5.24	2.11	5.96	0.54	6.45

* a 曳網數 No. of haul. b 總漁獲量 Total catch. c 黑口漁獲量 Catch of black croaker. d 黑口單位漁獲量 Catch per unit of effort of black croaker.

第三表 1956 年 19 艘拖網漁船作業分析表

Table III. Analysis on Operations of 19 Trawlers in 1956

漁區 District / 月份 Month		T	S	E	200	209	210	217	218	219	273	274	275	277	278	279	288	388	合計 Total
一月 Jan.	*a	8	208			5	69	12	148	141			198	30		4	280	16	1,119
	b	148	3,524			71	1,180	190	1,942	2,254			3,308	602		58	7,001	224	20,502
	c	34	208			6	372	2	35	346			34	9			5		1,051
	d	4.25	1			1.2	5.39	0.17	0.24	2.45			0.17	0.30			0.02		0.94
二月 Feb.	a	4	65	1		1	71	3	46	348			57	15		19	60	1	6.91
	b	80	909	35		13	1,216	23	665	8,010			1,057	260		305	1,070	23	13,666
	c	2	181	33			509		25	4,380			56	4		5		4	5,199
	d	0.50	2.78	33			7.17		0.54	12.59			0.98	0.27		0.26		4	7.52
三月 March	a	4	97				157	6	183	575			201	33	3		124	7	1,390
	b	59	1,644				2,664	152	2,711	12,700			3,011	541	53		2,759	61	26,355
	c	7	439				484		61	5,220			89	4	1			11	6,316
	d	1.75	4.53				3.08		0.33	9.08			0.44	0.12	0.33			1.57	4.54
四月 Apr.	a	13	108			3	240	130	51	694	366	239	140	8	8	6		37	2,035
	b	173	1,557			38	4,466	1,542	696	12,250	6,564	5,104	2,103	130		32		502	3,5157
	c	14	107				848	19	44	3,224	97	72	11	3					4,439
	d	1.08	0.99				3.53	0.15	0.86	4.65	0.27	0.30	0.08	0.38					2.18
五月 May	a				51		1,845			792									2,688
	b				1,517		54,840			17,882									74,239
	c				123		6,495			4,128									10,746
	d				2.40		3.52			5.21									4.00
六月 June	a				8	2	1,450		16	630			9						2,115
	b				167	22	32,360		266	13,410			96						46,321
	c				43	1	5,260		7	1,776			1						7,088
	d				5.38	0.50	3.63		0.44	2.82			0.11						3.35
七月 July	a		2				1,140		8	408			9						1,567
	b		31				22,040		133	9,039			91						31,334
	c						3,490		20	1,122			8						4,640
	d						3.06		2.50	2.75			0.89						2.96
八月 Aug.	a						840			360									1,200
	b						18,008		33	6,978									25,019
	c						3,264			1,224									4,488
	d						3.89			3.40									3.74
九月 Sep.	a	10	85				348			147			2						592
	b	169	973				12,405		36	5,297			16						18,896
	c	8	2				2,253			1,074									3,337
	d	0.80	0.02				0.47			7.31									5.64
十月 Oct.	a						702			618									1,320
	b						16,308			16,824									33,132
	c						5,268			4,362									9,630
	d						7.50			7.06									7.30
十一月 Nov.	a						672		1	396									1,069
	b						23,478		10	14,640									38,128
	c						7,707		4	3,994									11,675
	d						11.47		4	10.01									10.92
十二月 Dec.	a	8	9				896			530			5					7	1,455
	b	143	82				20,088			12,010			40					168	32,531
	c	37	31				10,712			6,450			1					50	17,281
	d	4.63	3.44				11.96			12.17			0.20					7.14	11.88
合計 Total	a	47	574	1	59	11	8,430	151	453	5,639	366	239	621	86	3	29	364	68	17,241
	b	772	8,720	35	1,684	144	209,053	1,907	6,492	131,294	6,564	5,104	9,722	1,533	53	395	10,830	978	395,280
	c	102	968	33	166	7	46,662	21	196	3,270	97	72	200	20	1	5	5	65	85,890
	d	2.27	1.69	33	2.81	0.64	5.54	0.14	0.43	6.61	0.27	0.30	0.32	0.23	0.33	0.17	0.01	0.96	4.98

* a 曳網數 No. of haul. b 總漁獲量 Total catch. c 黑口漁獲量 Catch of black croaker d 黑口單位漁獲量 Catch per unit of black croaker.

district 219 (6.61 boxes). Record of November was 10.92 boxes. February, October and September were the months which possess records above 5 boxes. The record of district 210 dropped to 5.54 boxes and records of all other districts are below 3 boxes.

THE NUMBER OF HAULS

The annual number of hauls were nearly the same in both years (17,213 hauls in 1955 and 17,241 hauls in 1956). It appears also that the fishing effort of the trawlers has been concentrated to the same months and to the same districts in both 1955 and 1956. In 1955, the months in which more than two thousand hauls are operated were June and April and the districts were 210 (9,989 hauls) and 219 (2,819 hauls). In 1956, the months in which more than two thousand hauls were operated were also April and June and the districts were 210 (8,430 hauls) and 219 (5,639 hauls).

COMPARISON WITH PREVIOUS REPORTS

Variations of the length frequency distribution and of the age composition in the three reports are complicated. The percentage of individuals with scales of one annulus (body length 16 cm and less) continuously increases but that of the individuals with scales of two annuli (body length 17 cm and 22 cm) shows remarkable decrease as compared with that of the previous reports. Moreover, the percentage of the individuals with scales of three and more annuli (body length 23 cm and more) seemed larger than that of the second report and smaller than that of the first report. If the whole population is divided into two classes, one the immature class consisting of the individuals with scales of one and two annuli and the other, the spawning class composed of the individuals with scales of three and more annuli, it is found that the former has a smaller percentage than that of the second report and a larger percentage than that of the first report while the percentage of the latter is larger than that of the second report and smaller than that of the first report.

The condition of the total catch of various years is shown in tables 4 and 5. It is worthwhile to notice that the total catch of all kinds of fishes from all fishing districts showed a tendency to increase year after year during years 1952 to 1955 but began to decrease in 1956 during which more fishing effort has been put out than in the previous years. The total catch of the fishing district 210, the fishing center, shows the same phenomena. As to the black croaker, marked decrease in 1956 has also been found in either the total catch of the various districts or that of the district 210.

The catch per haul of either the total catch of various kinds of fishes of various districts or of that of district 210 shows a decrease in 1956 in comparison with that in 1955. However, the condition is very irregular on looking back to the earlier years. Decreasing of the catch per haul of the black croaker of various districts in 1956 is prominent. This has been shown in district 210 in gradational manner, that is a decrease year after year during five years (tables 4 and 5).

DISCUSSION AND CONCLUSION

It has been predicted in the previous reports that the stock of the black croaker is disappearing. This condition becomes much more serious as being observed from the prsent study.

Biologically, the complication of the variation of the age classes makes it difficult for interpretation, although a stock with less recruiting young is not as prosperous as that with more recruiting young and the destruction of the recruiting young might be more harmful to the stock than the destruction of the spawning individual. The percentage of the recruiting young is found larger than that of previous reports. Moreover, the catch composed of mostly small individuals is usually not economical. It is quite reasonable to say that the quality of the stock has become worse than that of previous years because the individuals with scales of one annulus which are only 16 cm or less has reached to 61.67% of the total stock. The complication of the variation of the percentage of various age classes in various years is hazardous. It may be either due to the immigration and the emigration of different stocks or due to the different age classes of the same stock that inhabit different habitats. This needs further investigation.

The concentration of the fishing effort to the fishing centers is more and more one year after another (table 5.) Such concentration has made to increase the total catch of the black croaker of various districts and that of district 210 in the previous years. The drop of the total catch of various districts in 1956 seems serious. The catch per haul of the black croaker of various districts has also dropped since 1956. It indicates certainly that the catch or stock of black croaker of the observed region is continuouly lessening during the observed years as it was so interpreted in previous reports yet this does not mean exactly the disappearance of the whole population black croakers. It is too early to draw such a conclusion on the whole population because it is not understood whether this stock is an indepandent stock and on the other hand more clear understanding about its population structure is needed before more adequate statistical methods can be employed. Moreover, it is necessary to wait for data from more years.

The fishing intensity is still increasing either in various districts or in fishing centers (tables 4 and 5). It has been shown in district 210 that there was a decrease in intensity in 1956 but this has been compensated by the increase in intensity in district 219 which is usually a secondary fishingi center of the black croaker. Judging from the difference of the catch per haul, the fishing center is found to be shifting from district 210 to 219 in both years since that of district 210 was 7.58 boxes in 1955 and 5.54 boxes in 1956 and that of district 219 was 8.73 boxes in 1955 and 6.61 boxes in 1956.

第四表 全調查海域 1952—1956 年漁獲情況

Table IV. Total catch of Various fishing districts in 1952—1956

項目 Items / 年次 Year	(A) 曳網數 No. of haul	黑口 Black croaker		總漁獲物 All kinds of fish		黑口之百分比 Percent of black croaker
		總箱數 Total boxes	一網平均 Boxes per haul	總箱數 Tatal boxes	一網平均 Boxes per haul	
1952	9,142	21,458	2.35	175,868	19.24	12.20%
1953	12,870	67,613	5.25	282,110	21.92	23.97%
1954	13,557	81,330	6.00	298,238	22.00	27.27%
1955	17,213	111,064	6.45	398,154	23.13	27.89%
1956	17,241	85,890	4.98	395,280	22.93	21.73%

第五表 210 漁區 1952—1956 年漁獲情況

Table V. Total catch of fishing district 210 in 1952—1956

項目 Items / 年次 Year	(B) 曳網數 No. of haul	黑口 Black croaker		總漁獲物 All kinds of fish		漁獲努力集中情況 Concentration of fishing intensity (B/A)*
		總箱數 Total boxes	一網平均 Boxes per haul	總箱數 Total boxes	一網平均 Boxes per haul	
1952	1,548	17,334	11.20	36,963	23.88	16.93%
1953	4,882	52,851	10.83	126,820	25.98	37.93%
1954	7,686	67,545	8.79	179,593	23.37	56.69%
1955	9,989	74,915	7.58	270,724	27.10	58.03%
1956	8,430	46,662	5.54	209,049	24.80	48.90%

* B/A=Ratio of number of haul in fishing district 210 and that in various districts.
210 區曳網次數與各漁區曳網次數之比例。

摘 要

劉發煊 陳金城

此爲黑口研究之第三報告，關於生物方面之觀察，在年齡組合上發現有難解之複雜情形。一輪魚之百分比在繼續增高而二輪魚之百分比却比以往爲低，至三輪以上魚之百分比則比第二次報告者高而比第一次報告者低，此種複雜性或係由于異族之移入與移出，亦可能因不同年輪之同族有不同居住之習性，須要繼續之研究。黑口之族羣在質的方面之變劣迨爲無疑，因一輪魚之百分比已增至61.67%，此種小魚，市場價值甚低，漁獲分析得悉黑口產量益形降低，往年各區總漁獲量及各區單位漁獲，由于漁獲努力之向密集中心之集中而有增加，此種情況已不復存在，1956年漁獲努力雖在增加，但黑口總產量及單位漁獲量均已有減少之勢，210 區方面之情形亦復如是，就單位漁獲論，黑口之密集中心已有由 210 區而移至 219 區之趨勢。

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勘誤表

Errata

面 Page	行 Line	字 Word	誤 Error	正 Correction
3	14	9	tendencg	tendence
14	4	16	rocorded	recorded
24	31	5	woks	works
28	10	13	chin-shan	Chin-Shan
28	27	4	weae	were
30	16	10	*mieropus*	*micropus*
30	29	1	Stolephorus	*Stolephorus*
30	29	2	pseudoheterolobus	*pseudoheterolobus*
30	31	14	Ilisha	*Ilisha*
30	31	15	indica	*indica*
31	1	3	*dessumieri*	*dussumieri*
31	17	5	earlies	earlier
33	1	9	North	Northern
33	29	6	thighest	highest
34	Fig. 2	2	composit5ion	composition
36	25	14	missing	of
36	34	8	fishingi	fishing

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